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BARI Annual Report 2016-17

Bangladesh Agricultural Research Institute

Joydebpur, Gazipur-1701

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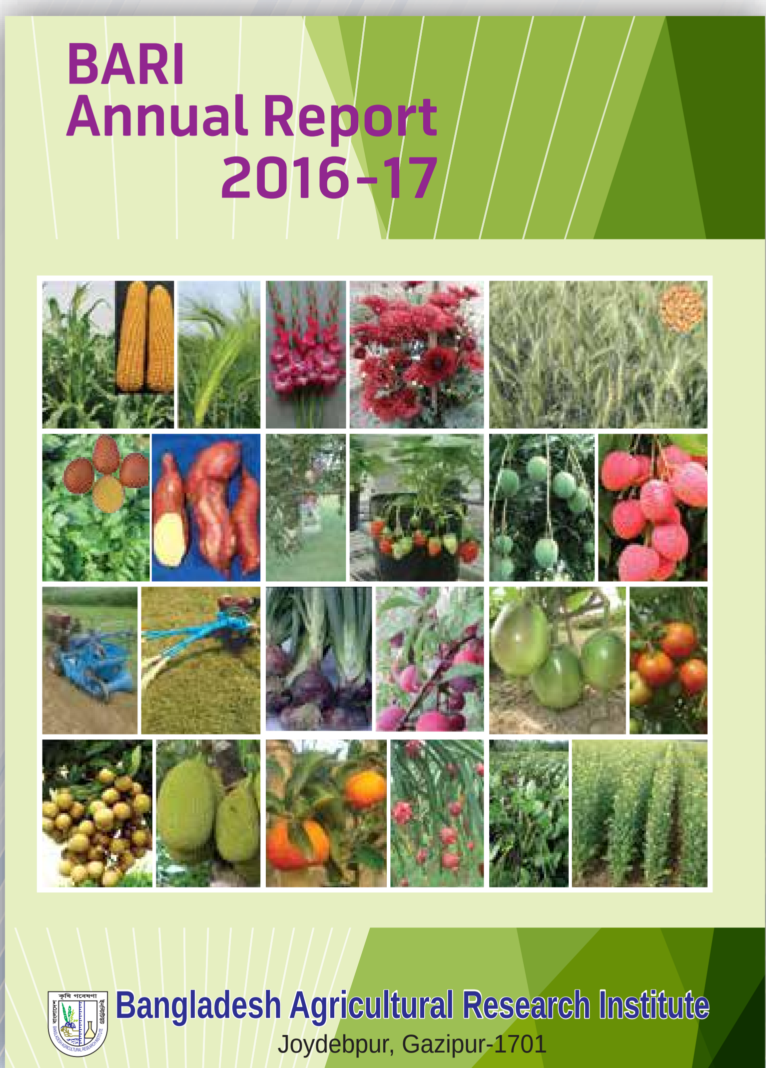

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Foreword

This report contains the major findings of the experiments conducted by the scientists of the Institute during the year 2016-17. Major research areas include variety development of various crops, such as cereals (wheat, maize, millet, barley, and sorghum), tubers (Potato, sweet potato, aroids etc.), oilseeds (mustard, rapeseed, groundnut, sunflower, safflower, linseed, niger etc.), pulses (grasspea, lentil, chickpea, mungbean, blackgram, cowpea, pigeonpea etc.), horticultural crops (fruits, vegetables and flowers), and spices (onion, garlic, turmeric, ginger, fenugreek, etc.). Thrust was placed on such non-commodity areas as cropping systems, soil and water management, plant nutrition, disease and pest control, production economics, development of low-cost farm tools and machinery, postharvest processing, irrigation and farm management. Attention was focused on plant biotechnological research, improvement of floriculture and hill farming. Our scientists are engaged in developing technologies which are appropriate as well as sustainable with a view to narrowing the gap between food demand and its production.

The annual report synopsizes the total research activities of the year under report. It is however not possible to accommodate all the conducted experiments along with their detailed narratives and data in tabular form in such a volume. So like previous years, only the major findings of the studies have been incorporated in this report. The readers can get the real flavor and information of any of the studies in brief. In case anybody wants to have all the generated data, he or she may go through the centre or divisional reports.

I hope this report will be useful to the scientists, teachers, students, policymakers, and others who are engaged in agricultural research and development in Bangladesh.. I express my heartfelt thanks to those who worked hard to bring this report out.

Dr. Abul Kalam Azad
Director General, BARI

Bangladesh Map

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- Two eminent scientists, one in social science and other in the field pertaining to the speciality of the Institute (nominated by the Ministry or the Division dealing with agriculture)
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- Two representatives, one from among the farmers and the other from among the non-Govt. Organizations (NGOs) performing functions similar to those of the Institute (nominated by the Ministry or Division dealing with agriculture)

The Director-in-charge of administration of the Institute acts as secretary of Board.

BARI Annual Report 2016-17

Bangladesh Agricultural Research Institute

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1 CEREAL CROPS

Wheat

Variety improvement

The main objective of this project is to develop high yielding wheat varieties with wide range of adaptability to enhance wheat productivity in Bangladesh. Development of heat tolerant variety has been given the highest research priority under the context of global climate change. Due emphasis has also been given to develop varieties against other abiotic stresses like drought, salinity, boron-deficiency, etc. Genetic improvement through incorporating stress adaptive traits into good agronomic background is being duly emphasized in the variety development programme. In addition, research thrust has been put forward towards developing varieties with improved nutritional quality. Efficient deployment of resistance genes into the genotypes with good agronomic background for major diseases like leaf rust, bipolaris leaf blight, stem rust, etc. is also considered as a priority area. The performance of newly developed wheat lines from national and international sources specially CIMMYT is being evaluated under different growing environments across the country and promising lines superior to the standard check varieties are selected.

Apart from that, Wheat Research Centre (WRC) maintains a unique crossing block having germplasm from diverse sources for hybridization. Segregating generations are advanced following selected bulk method. Every year hundreds of new lines are added in the nurseries/trial for performance evaluation. Wheat research activities on variety development during 2016-17 are described in this report.

Hybridization

In order to enhance wheat production in the country, it is important to increase the yield potentiality and resistance to diseases of the upcoming varieties. Yield potential can be increased through strategic crosses based on pyramiding yield potential traits, disease resistance, physiological traits conferring tolerance to abiotic stresses, etc. in the superior adapted genotypes. Thus, main objective of hybridization is to create variability by combining and recombining desirable genes in the background of different adapted genotypes. This will be further followed up through selection of desirable plants in subsequent generations to develop improved varieties. The hybridization programme was conducted at five research stations: Dinajpur, Joydebpur, Jessore, Jamalpur and Rajshahi. A total of 537 single crosses with 28 crosses were targeted to blast resistance, 56 top and 95 backcrosses were made this year to incorporate the desired genes in the adapted genotypes. The crosses made will be confirmed in next year

Confirmation and selection in F_1 generation

The objective of this nursery was to confirm F1 hybrids in respect to their female parents and to obtain seed for growing F_2 generation in the next season from the selected F_1 population. The nursery consisted of single, top and back cross F_1 hybrids along with female parents. F_1 hybrids along with female parents were sown on 20-30 November 2016 in the experimental farms of WRC at Dinajpur, Jessore, Joydebpur, Jamalpur and Rajshahi. Seeds of each F_1 hybrids were solid seeded in 2.5 m long 2 rows with 20 cm row spacing. The female parent was included at the starting of the crosses to confirm the F_1 hybrids comparing with phenotypes of the respective female parents. Recommended management practices with three irrigations were followed for normal growth and development of the crop. At maturity, each confirmed and selected F_1 hybrid was harvested, cleaned and seeds were preserved to grow F_2 generation in the next season. On the basis of phenotypic expression of hybrids with their respective female parents 601 F_1 populations were confirmed as hybrids. In addition, 53 Top cross and 78 Back cross F_1 populations were selected.

Evaluation and selection in different filial generations

The success of a hybridization programme depends on careful handling of segregating generations. It is often desirable to discard poor cross-combinations in early generation, so that adequate attention can be paid to really potential combinations. The main objective of handling segregating generations is to grow and select the desirable families and individual plants in different filial generations for further evaluation. Selected bulk method is minor modification of modified pedigree bulk method where selected individual plants are bulked in F_2 to F_4 generation and in F_5 generation individual plants are selected and grown in F_6 as plant to row. Promising F_6 families are selected and advanced in Bangladesh Wheat Screening Nursery (BWSN), thus minimize variety release time. Genetic gain is more in this method as compared to other method. Therefore, selected bulk method was followed during selection in F_2 to F_6 segregating generations.

Selected bulk method was followed during selection in F_2 to F_4 segregating generations. In F_5 pedigree method was followed. Selections were based on good vigor, earliness, medium height, disease and sterility tolerance and resistance, etc. The F_2 families were thoroughly evaluated in the field and 339 families were selected out of 639. Two hundred fifty three F_3 families and 182 F_4 families were selected out of 409 and 213 families, respectively. A total of 87 F5 families were selected from 115 families from where 1307 individual plants were selected based on field performance and physical grain characteristics. Two hundred seven F_6 families out of 949 were selected for evaluation in Bangladesh Wheat Screening Nursery (BWSN) for next season.

Germplasm maintenance

One hundred forty three wheat genotypes with special characteristics were selected from different trials and nurseries of various years but not recommended as varieties are maintained through this nursery. Different exotic genotypes with special features are also included in this nursery. Each entry was grown in 2.5m long 3 rows. The nursery was planted under irrigated timely sown condition at WRC, Dinajpur following recommended package of practices. A total 143 genotypes were included in this nursery. These materials with special characteristics are maintaining in this nursery for future use.

Bangladesh wheat screening nursery (BWSN)

Bangladesh Wheat Screening Nursery is an important nursery of wheat breeding programme of WRC. The selected genotypes from national nurseries like Heat Tolerant Screening Nursery and international nurseries and trials are included in this nursery. All the materials of this nursery are evaluated in this nursery before testing in yield trials. The objectives of this nursery were to select high yielding, disease resistance, short stature, and early maturing suitable genotypes for inclusion in preliminary yield trial. There were two sets of BWSN.

In the BWSN-I, Fifty genotypes selected from last year's F6, WVS, SAWYT included in this nursery along with Shatabdi and BARI Gom 26 as check varieties. The experiment was conducted under irrigated timely seeding (ITS) and irrigated late seeding (ILS) conditions at WRC, Dinajpur, Joydebpur and Jessore The experiment was planted in alpha-lattice design with 2 replications in each location. Unit plot size was 2.5m long 6 rows with 20 cm and 40 cm space between rows and entries, respectively. The performance of all genotypes, seeding times, locations and their different levels of interactions were statistically significant for different traits. The effect of seeding times revealed that all traits were significantly influenced by seeding time. Maturity was earlier at late sowing condition where as the days to heading were earlier at timely sown. The number of spikes m^{-2} and TGW were significantly higher at timely sown condition. The higher yield across location and genotype was recorded in ITS condition (4523 kg ha^{-1}) than ILS condition (2978 kg ha^{-1}). Both heading and maturity was earlier at Joydebpur and that was late in Dinajpur. The number of spikes m^{-2} was significantly higher at Dinajpur than other locations followed by Jessore. The grains per spike and TGW were recorded higher at Dinajpur followed by Joydebpur. The highest yield (4784 kg ha^{-1}) was recorded in Dinajpur and the lowest (2854 kg ha^{-1}) was in Joydebpur. Yield of Joydebpur was significantly lower than other locations. The performance of selected genotypes over locations and seeding times was statistically significant. All the selected genotypes matured earlier than the check variety Shatabdi. The lowest heading and maturity days were recorded in E-19. The highest number (311) of spikes m^{-2} was recorded in E-9 followed by E-30 and E-19. The highest number of grains $spike^{-1}$ (51) was recorded in E-30 and check BARI Gom 26. The highest (51.2 g) TGW was recorded in E-48. The highest yield (4436 Kg ha^{-1}) was recorded in E-30 followed by E- 13 (4158 Kg ha^{-1}) and E-9 (4127 kg ha^{-1}). The significant interaction effect of location, seeding time and genotype was observed for heading and maturity days. All the selected genotypes All the selected genotypes showed earlier heading than Shatabdi except E-13 (73 days) and E-48 (74 days) at Dinajpur in ITS condition. The lowest heading days (51) were recorded in E-22 at Joydebpur under ITS condition. The significant interaction effect of location, seeding time and genotype was observed for maturity. The highest maturity days was recorded in check variety Shatabdi (72 days) and E-48 (74 days) at Dinajpur in ITS condition. The earliest maturity was recorded in E-38 and 40 at Joydebpur under ILS condition. The significant interaction effect of location, seeding time and genotype was observed for TGW. The highest and the lowest TGW at Dinajpur were recorded in E-16 (60 g) and BARI Gom 26 (36.4 g) under ITS and ILS conditions, respectively. The highest TGW was recorded in E-48 (57.5 g) under ITS condition and the lowest was recorded in E-31 (29 g) under ILS condition at Jessore. The highest and the lowest TGW at Joydebpur were recorded in E-48 (59.9 g) and Shatabdi (37.4 g) under ITS and ILS conditions, respectively. All the lines produced higher grain yield under ITS than ILS conditions. The highest yield under ITS condition was recorded in E-30 (6542 kg ha^{-1}) at Dinajpur, E-30, 31 at Joydebpur and Shatabdi (5488 kg ha^{-1}) at Jessore, respectively. The lowest yield under ILS condition was recorded in Shatabdi (3218 kg ha^{-1}), E-16 (1600 kg ha^{-1}) and E-248 (2188 kg ha^{-1}) at Dinajpur, Joydebpur and Jessore, respectively. The highest yield loss (48%) due to late seeding was recorded in Shatabdi and the lowest (18%) was in E-19. Based on overall performances 16 genotypes viz. E-7, E-9, E-11, E-13, E-14, E-16, E-19, E-22, E-30, E-13, E-33, E-36, E-38, E-40, E-42 and E-48 were selected for next year.

In the BWSN-II, Fifty nine genotypes selected from last year's international trials were included in this nursery. The experiment was conducted under irrigated timely seeding (ITS) and irrigated late seeding (ILS) conditions at WRC, Dinajpur, Jamalpur and Rajshahi. The experiment was planted in alpha-lattice design with 2 replications for each location. Unit plot size was 2.5m long 6 rows with 20 cm and 40 cm space between rows and entries, respectively. The ITS and ILS sets were seeded on 21-26 November and 21-26 December 2016 respectively. Recommended package of practices were followed to raise the crop. Data were recorded on visual sterility, disease reaction, different agronomic characters, grain yield and physical grain characteristics. At maturity, the whole plots were harvested to estimate yield. The collected data were statistically analyzed and the means were compared by LSD. The performance of all genotypes, seeding times, locations and their different levels of interactions were statistically significant for different traits. The effect of seeding times revealed that all traits except spikelets $spike^{-1}$ were significantly influenced by seeding time. Most of the traits had significantly higher values in ITS condition than ILS. Significantly higher spike m^{-2} were observed in ILS condition.

Location effect revealed that all traits were significantly influenced by locations. Days to heading were significantly earlier (66 days) at Jamalpur and similar in Dinajpur and Rajshahi. Earlier maturity was observed in Jamalpur (101days) than the other two locations. Dinajpur location favoured to produce taller wheat plants than other two locations. The number of spikes m^{-2} was significantly higher (406) at Dinajpur identically followed by Jamalpur and Rajshahi. All the yield contributing characters and yield were higher in Dinajpur than other locations. The highest yield (4246 kg ha^{-1}) was recorded in Dinajpur and the lowest yield (2496 kg ha^{-1}) was recorded in Rajshahi.

The performance of selected genotypes over locations and seeding times was statistically significant. Most of the selected genotypes matured at per or earlier than the check variety Shatabdi. The lowest heading days (62) were recorded in E-48 and the lowest maturity days (100 days) were in E-33 and E-48. The highest number of spikes m^{-2} (349) was recorded in E-30. The highest number of grains $spike^{-1}$ (55) was recorded in E-31followed by E-30. The highest TGW (40.9 g) was recorded in Shatabdi. The highest yield (3916 kg ha^{-1}) was recorded in E-30 followed by entry E-32 and E-33. The significant interaction effect of location, seeding time and genotype was observed for all the traits except spiketlets $spike^{-1}$. Heading was early at at Jamalpur both in ITS and ILS conditions. The significant interaction effect of location, seeding time and genotype was observed for maturity days. The highest maturity days was recorded in E-50 (117 days) followed by E-32 (116 days) and E-49 (115) at Dinajpur in ITS condition. Highest and Lowest maturity was recorded in E-50 and E-48 in Rajshahi at ITS and Jamalpur at ILS condition, respectively. The significant interaction effect of location, seeding time and genotype was observed for thousand grain weight (TGW). The highest TGW (49.9 g) was recorded in E-35 at Dinajpur in ITS condition and the lowest TGW (24g) was recorded in E-13 and E-14 at Jamalpur in ILS conditions. The significant interaction effect of location, seeding time and genotype was observed for yield. All the lines produced higher grain yield under ITS than ILS conditions. The highest yield under ITS condition was recorded in E-32 (6708 kg ha^{-1}) at Dinajpur. The lowest yield under ILS condition was recorded in E-14 (1800 kg ha^{-1}) at Jamalpur. The highest yield loss (37%) due to late seeding was recorded in E-13 and 14 and the lowest (14%) was in E-33. Based on overall performances 2 genotypes viz. E-32 and E-33 were selected for inclusion in PYT next year.

Preliminary yield trial (PYT)

After passing Bangladesh Wheat Screening Nursery, the advance lines are tested for yield over locations in different growing conditions. Therefore, assigned Preliminary Yield Trial was conducted to evaluate the performance of the advance lines compared to the existing check varieties and select the promising lines for inclusion in the Advance Yield Trial (AYT) next year.

The trial includes 36 promising lines selected from BWSN last year (2015-16). Shatabdi, BARI Gom 26, BARI Gom 30 were used as checks. The experiment was laid out in RCBD factorial design with three replications at three locations (Dinajpur, Joydebpur and Jessore). The trial in each location was planted under irrigated timely sown (ITS) and irrigated late sown (ILS) conditions. Seeds were sown continuously in 5 m long 8 rows plots with a row spacing of 20 cm. The effect of seeding times revealed that all traits were significantly influenced by seeding time. Days to heading were earlier at optimum seeding condition because of low temperature in February. The numbers of spikes m^{-2} were also significantly higher at late sown condition but days to maturity, grains $spike^{-1}$, thousand grain weight (TGW) and grain yield were higher in ITS condition. The effect of location revealed that all traits were significantly influenced by the locations. Days to heading and days to maturity were earlier at Joydebpur and that was late in Dinajpur. Values for all the traits were higher at Dinajpur than Jessore and Joydebpur except TGW. The average yield was highest at Dinajpur than other two locations. All the selected genotypes headed and matured earlier than the check variety Shatabdi and BARI Gom 26. All the selected genotypes produced higher grain yield than check variety Shatabdi except BAW 1295. The highest yield was recorded in BAW 1318 (3616 kg ha^{-1}) followed by BAW 1317 (3433 kg ha^{-1}). Thousand grain weights (g) of selected entries were higher than 3 check varieties, but other traits like spike m^{-2} and grains $spike^{-1}$ were higher in check varieties. However few selected have higher spike m^{-2} and grains $spike^{-1}$ compared to check Shatabdi and BARI Gom 26 and BARI Gom 30.

The Interaction effect of genotypes, locations and sowing times was statistically significant for all the traits. Heading days was significantly influenced by the interaction effects of genotypes, locations and sowing times. The highest heading days (70) was obtained in ILS condition at Dinajpur (Shatabdi) whereas the lowest heading days (47.5) was observed in ITS condition at Joydebpur (BAW 1295). All the genotypes matured taking longer time in ITS condition at all locations compared with ILS conditions. The highest maturity days (112) was observed in optimum seeding condition at Dinajpur (check Shatabdi) whereas the lowest maturity days (86) was observed in BAW 1203 and BAW 1217 in ILS condition at Joydebpur, respectively.

Spikes per square meter were significantly influenced by the interaction effects of genotypes, locations and sowing times. The highest spikes m^{-2} was obtained in check Shatabdi (508) ILS condition at Dinajpur whereas the Check BARI Gom 30 produced the lowest spikes m^{-2} (170) in ITS condition at Joydebpur. All the genotypes produced higher spikes m^{-2} in ILS condition at Dinajpur compare to ITS condition, whereas lowest at Joydebpur in ILS condition. Result shows significant variations for TGW. The highest TGW (62g) was achieved in BAW 1293 in ITS conditions at Joyedebpur followed by BAW 1317 (61.2g) in ITS conditions at Dinjapur. The lowest TGW (26g) was obtained in ILS conditions at Jessore due to wheat blast. The TGW for all genotypes were higher in ITS condition compare to ILS condition over all three locations. The TGW gradually decreases significantly with the delay of sowing times because grain formation is directly influenced by temperature in late sown condition. The interaction effect of grain yield for genotype, location and seeding time showed significant variations for grain yield. The grain yield gradually decreased significantly with the delay of sowing times at two locations viz Joydebpur and Jessore. On the other hand, all the selected genotypes produced higher yield than three checks at Dinajpur in ILS condition except BAW 1303. The highest grain yield (4848 kg ha^{-1}) was obtained in BAW 1317 at Dinajpur in ILS condition. The lowest grain yield (1418 kg ha^{-1}) was obtained in check variety BARI Gom 26 at Jessore under ILS condition. The highest yield loss (43%) due to late seeding was recorded in check BARI Gom 26 followed by check Shatabdi (6%), BARI Gom 30 (22%) and BAW 1303 (22%). BAW 1293 produced 7% higher yield in late sown condition than optimum sown. The lowest yield loss (2%) were recorded in BAW 1717 followed by BAW 1716 (9%). Considering the overall performance, 11 genotypes BAW 1290, BAW 1295, BAW 1296, BAW 1297, BAW 1299, BAW 1303, BAW 1304, BAW 1316, BAW 1317 and BAW 1318 were finally selected for testing in AYT next year.

Advance yield trial (AYT)

The selected outstanding genotypes from Preliminary Yield Trial are included in this trial for further evaluation across different agro-ecologic conditions to confirm the stability over the environments in respect to grain yield, disease reaction, etc. Therefore, the objective of this trial was to evaluate the performance of the advance lines compared to the existing varieties and select the promising lines for further evaluation in multi-location trials at farmers' field.

The trial was conducted with eleven promising lines selected from PYT 2015-16. Shatabdi, BARI Gom 26 and BARI Gom 30 were used as checks. The experiment was laid out in RCB factorial design with three replications at six locations (Dinajpur, Joydebpur, Jessore, Jamalpur, Rajshahi and Ishurdi). The trial was sown under irrigated timely sown (ITS), irrigated late sown (ILS) and irrigated very late sown (IVLS) conditions in each location. Seeds were sown continuously in 5m long 8-row plots with a row spacing of 20 cm. Recommended cultural practices were followed to raise the crop. Data were recorded on different agronomic characters, diseases, sterility, 1000-grain weight and visual seed characteristics. At maturity, the middle five-meter long five rows were harvested to estimate yield. The double-digit disease scores were converted to percent diseased leaf area (% DLA) for BpLB disease. The collected data were analyzed using Cropstat programme.

The effect of seeding times revealed that all traits were significantly influenced by seeding time. Days to maturity were earlier at late sowing condition. The number of spikes m^{-2} was significantly higher at ILS condition. The TGW was higher at ITS condition compared to both ILS and IVLS conditions. The higher yield was achieved under ITS than ILS and IVLS condition. The effect of locations on yield and other related traits showed that the height yield was achieved at Dinajpur (3397 kg ha^{-1}) followed by Joydebpur (3214 kg ha^{-1}). The lowest yield was recorded at Jessore (2225 kg ha^{-1}). Earlier heading, maturity, shorter plant with lower number of spikes m^{-2} was recorded in Joydebpur. All the tested genotypes headed and matured earlier than the check variety Shatabdi. The highest spike m^{-2} was recorded in BAW1285 which was statistically higher than both of the check variety. Out of eleven genotypes tested seven had higher 1000-grain weight than all three check varieties. The highest 1000-grain weight was recorded in BAW 1272 followed by BAW 1263 and BAW 1278. The lowest 1000-grain weight was showed in BAW 1284. All the selected genotype out yielded both Shatabdi and 26. The highest yield was achieved in BAW 1286, followed by BAW 1272 and BAW 1280. The effect of seeding time, genotypes and their interactions over locations on TGW showed that the highest TGW was recorded in BAW 12878 (56.2 g) at Dinajpur followed by BAW 1263 (55.4 g) at Joydebpur and BAW 1278 (53.1g) at Rajshahi under ITS condition. The lowest TGW was recorded in BARI Gom 26 (15.3 g) at Jessore under IVLS condition. The effect of seeding time, genotypes and their interactions over locations on grain yield showed that the highest yield was achieved in BAW 1286 (5200 kg ha^{-1}) at Dinajpur and Ishurdi (5060 kg ha^{-1}) under ITS condition, followed by BAW 1283(4623 kg ha^{-1}) at same location and condition. The lowest yield was recorded in BARI Gom 26 (503 kg ha^{-1}) at Jessore under IVLS condition. The highest yield loss (47%) due to late seeding was recorded in check BARI Gom 26 followed by check Shatabdi (44%). Maximum yield loss (60%) was recorded in BARI Gom 26 due to very late seeding. Considering the overall performance over locations, seeding times and genotypes and their different interactions on yield and other characters, disease reactions and visual grain quality the genotypes BAW 1272, BAW 1280 and BAW 1286 were finally selected for further evaluation in candidate variety trials next year.

Candidate variety demonstration (CVD)

The advance lines are usually tested in comparatively larger plots in on-station under optimum and late seeding conditions before on-farm testing. Therefore, to select genotypes for Farmers' Field Trial at MLT sites, the trial was conducted to evaluate the performance of the advance lines against the check varieties Shatabdi and Prodip. Ten promising candidate varieties were evaluated in this trial against the check varieties Shatabdi and BARI Gom 26. The trial was conducted in optimum and late seeding conditions. The unit plot size was 5m x 4m at each location. The experiment was sown in Dinajpur and Jessore during 22 November (ITS) and 25 December (ILS), 2016 in non-replicated plots. Recommended cultural practices were followed to raise the crop. Data were collected, compiled and analyzed in RCB design considering each location as dispersed replication. The effect of seeding times revealed that all characters under study were significantly influenced by seeding time. Effects of genotypes, seeding time and their interaction over locations showed that there was no significant yield difference due to genotypes. The highest yield was recorded in BAW 1194 (4985 kg ha^{-1}) at Dinajpur in ITS condition and the lowest yield was recorded in BARI Gom 26 (660 kg ha^{-1}) at Jessore in ILS condition. The highest blast infection was observed in BARI Gom 26 (100%) and the lowest blast infection was observed in BAW 1260 (trace). Six genotype shows moderately tolerance to resistance reaction to blast disease. Considering the overall performance over locations, seeding times and genotypes and their different interactions on yield and other characters, plant stature, disease reactions, visual grain quality etc. the genotypes BAW 1194 and BAW 1203 could be tentatively selected for evaluation in MLT sites next year. BAW 1208, BAW 1253 and BAW 1254 will be evaluated in same trial next year.

Selection and evaluation of elite wheat lines against wheat blast disease

The present experiment was conducted at WRC, Dinajpur and RARS, Jessore having five elite wheat genotypes along with BARI Gom 30 as check. It was conducted under irrigated timely seeding (ITS), irrigated late seeding (ILS) condition. The trial was laid out in RCB design with 3 replications. Unit plot size was 2.5 m long 6 rows with spacing 20 cm between rows and 60 cm between plots. The distance between replications was 1.2 meter. Seeds were sown on November 27, 2016 for ITS condition and December 23, 2016 for ILS condition at WRC, Dinajpur and November 28, 2016 for ITS and December 28, 2016 for ILS condition at RARS, Jessore. The mean performance of the elite wheat genotype over location revealed that the genotypes required longer heading and maturity days in Dinajpur than Jessore. Significantly higher number of spikelet per spike & grains per spike, 1000-grain weight as well as yield was found in Dinajpur than Jessore. However, higher number of spikes per square meter were found in Jessore than Dinajpur.

Higher yield was found in irrigated timely sown (ITS) condition than irrigated late sown (ILS) condition as all the yield attributable traits exerts their effects significant positively toward yield. It also got longer heading and maturity days and plant became taller in ITS condition than ILS condition. The interaction effect indicates that highest heading and maturity time was required in Dinajpur, ITS condition and the lowest in Jessore, ILS condition. Similar plant height was found in ILS condition in both the location but plant became taller in Dinajpur ITS condition than Jessore ITS condition. There was significant variation in spikes per square meter for both the locations and sowing time. Highest number of spikes were found in ITS condition and the lowest was found in ILS condition in Dinajpur. Number of spikelet were similar in both the sowing time in both location except ILS in Jessore. Highest grain per spike, 1000-grain weight and yield was found in Dinajpur ITS condition and lowest was found in Jessore ILS condition except lower yield in Dinajpur ILS condition as there was rain and storm caused lodging of wheat plant in Dinajpur before harvesting.

Mean performance of the five genotypes over check indicated that all the five genotypes had higher heading and maturity period than the check BARI Gom 30. Genotypes were taller than the check except genotype 6 had higher grains per spikes but have lower 1000-grain weight. No genotype had higher mean yield than the Check BARI Gom 30 however, all the genotypes had more than four ton yield per hector except genotype 3. Considering performance of the five elite wheat genotypes in different sowing time it was found that late sown reduced the performance of genotype 3 and 6 higher than the other genotypes including check. Genotype 2, 4 and 5 had significant higher yield in late sown condition than the other two genotypes. Higher 1000-grain weight was also found in genotype 2 after BARI Gom 30 in both the ITS and ILS condition. As Jessore had blast infection the yield was little bit lower than Dinajpur, however Genotype 2, 4 and 5 have given stable yield over the location. The yield data and the GGE biplot from these data revealed that genotype 3, 4 and 5 was the best genotype in both the location and sowing time. These three genotypes were also more stable along with the check than the genotype 2 and 6. Genotype 4 had no blast infection in ITS condition but it had 60% blast infestation in late sown condition. Genotype 5 had comparatively lower blast infestation, 20% in ITS and 30% in ILS condition whereas genotype 2 had no blast infection in both ITS and ILS condition. Other two genotypes including check had more than 60% blast infestation in both ITS and ILS condition. Considering all these issues, genotype 2 and genotype 5 can be selected and evaluated in multi-location trial as promising lines in next season. Considering overall performance of the elite wheat genotypes over locations in ITS and ILS condition and the wheat blast score in RARS, Jessore two genotypes viz., genotype 2 and 5 can be promoted to multi-location trial.

Adaptive trial with advanced wheat lines

After identifying promising wheat lines with higher yield and visual grain quality in yield trials, it is important to evaluate these lines further in different agro-ecological zones under farmers' conditions. This trial facilitates to show the better performance of promising wheat lines as compared to check to the farmers. It also helps National Seed Board (NSB) evaluation committee to evaluate the lines for recommendation to release them as varieties. So, this trial was conducted at Multi Location Testing (MLT) sites with advance wheat lines to evaluate and show their performance to farmers and NSB committee members. The main objectives of the trial was to evaluate yield performances of new wheat lines in comparison to the check in different agro-ecological zones and to identify high yield potential and disease resistance variety.

The trial was conducted in OFRD and Titas (farmer's field) of Comilla, WRC and Bhatgon (farmer's field) of Dinajpur, RWRC of Gazipur and Mirzapur (farmer's field) in Tangail, RARS and farmer's field of Jamalpur, RARS and farmer's field of Jessore, RWRC and farmer's field of Rajshahi during the rabi season of 2016-17. The design was RCB with three replications. Three advance wheatlines BAW1194, BAW1203 and BAW1260 were evaluated along with check BARI Gom 24(Prodip). Unit plot size was 20 m2. The nursery was fertilized with NPK and S @ 100, 60, 40 and 20 kg ha^{-1}, respectively. Two-thirds of the urea and the entire quantity of triple super phosphate, muriate of potash and gypsum were applied at final land preparation. Recommended package of practices were followed to raise the crop under irrigated timely sown condition. First irrigation was given at crown root initiation (CRI) stage followed by a top dress with one-third of the recommended urea. Second and third irrigations were given at late booting and early grain filling stages, respectively. Yield data was collected from these sites and analyzed by R software. The yield from the twelve different sites showed that the highest yield (6037 kg ha^{-1}) was obtained from BAW1260 at WRC, Dinajpur and the lowest yield (2597 kg ha^{-1}) from check variety Prodip in farmer's field at Jessore. Ranking genotypes by GGE biplot indicates that genotypes located closer to the ideal genotype are more desirable than others. In this trials BAW 1203 was more desirable genotype for these location according to GGE biplot whereas prodip performed worse. GGE biplot analysis also revealed that Dinajpur 2 was the ideal location for genotypes evaluation followed by Tangail, Dinajpur1 and Comilla 1. For broad selection, the ideal genotypes are those that have both high mean yield and high stability (defined as genotype group one). In the biplot, they are close to the origin and have the shortest vector from the average environment axis. On the other hand, for specific selection, the ideal genotypes are those that have high mean yield but low stability and respond best to particular environments. Mean versus Stability showed that BAW 1260 was the best performer in Dinajpur1 and 2 location whereas BAW 1194 was the best performer in Comilla, Tangail and Jamalpur location but BAW 1203 was more stable variety. Based on overall performance and disease severity in different locations BAW 1194 and BAW 1260 was selected for release.

Early heat tolerance screening nursery (4th EHTSN)

Early heat tolerance screening nursery was established with a view to evaluating selected promising genotypes, lines from different national and international nurseries/trials for early heat tolerance and high yield potential in early seeding condition and selecting promising lines for inclusion in preliminary yield trial and or using as parent. Twenty high yielding spring wheat genotypes including three check varieties Shatabdi BARI Gom 26 and BARI Gom 30 were evaluated at Dinajpur and Rajshahi under early sown condition during Rabi, 2016-17. The experiment was undertaken to study the effect of early heat stress for yield and yield components viz; plant height, heading, maturity, TGW and grain yield. Significant variations were observed among the genotypes for all the traits studied. The genotypes varied significantly for yield and other characters over locations.

Drought tolerant wheat yield trial (4th DTWYT)

A total of 35 advanced lines were included in this nursery. The experiment was sown at RWRC, Rajshahi experimental field on 01 December, 2016. The genotypes were evaluated for yield and yield components, heading, maturity, disease reaction, sterility, visual grain quality etc. Significant variations were observed among the genotypes for all traits. On the basis of overall field performance and preferences of evaluation committee, nine entries viz; E-5, E-7, E-10, E-14, E-20, E-21, E-23, E-26 and E-35 have selected for further evaluation in farmers field in the next season.

Wheat variety selection for drought prone area (3rd WVS)

A total of 8 genotypes were included in this trial. The experiment was sown at RWRC, Rajshahi experimental field on 01 December, 2016 and Sapahar at 29 November 2016. The genotypes were evaluated for yield and yield components, heading, maturity, disease reaction, sterility, visual grain quality, etc. Significant variations were observed among the genotypes. On the basis of overall field performance two entries viz., E-5, and E-6 have selected for further evaluation.

Production of wheat double haploids through wheat x maize crossing

Wheat crop is facing more abiotic stress like heat, drought, and salinity over last few years due to global climate change and varieties are becoming susceptible to different diseases, which reduce varietal sustainability. So, there is an urgent need to develop more abiotic stress tolerant varieties. In conventional breeding method, it requires several generations for getting homozygous lines to develop wheat varieties which is a time consuming process. Recent advances in doubled haploid (DH) production enabled the development of homozygous lines instantly from a crop plant. The production of uniform homozygous lines enhances selection efficiency, allowing a better discrimination between genotypes in breeding nurseries within only one generation, making it a useful technique for both wheat breeding and genetical studies.

The procedure is practiced in different research institutes/countries to reduce the time period for variety development. Therefore, the present study was proposed to develop an efficient doubled haploid production system for wheat breeding in Bangladesh. This programme was conducted by Regional Wheat Research Center (RWRC) in collaboration with Breeding division of BARI. The experiment was carried out at the field of RWRC, greenhouse and laboratory of Breeding Division of BARI, Gazipur. Fourteen F2 segregating generations of wheat (*Triticum aestivum* L.) were sown in November, 2016 and used for wheat X maize crossing. BARI Maize 7 was sown in October, 2016 on four dates with seven days interval to synchronize wheat anthesis and ensure maize pollen availability throughout the reproductive stage of the wheat crop.

A total of 346 wheat florets from fourteen F_2 generations of wheat were pollinated with the maize pollens from where 288 green parthenocarpic caryopsis (GPC's) were developed which was 83.24% of total pollinated florets. A total of 143 embryos (49.65% of GPC's) were rescued from GPC's of fourteen F_2 generations and transferred to Petridis containing MS basal medium. Ninety six embryos (67.13% of total embryos) were germinated out of 143 embryos cultured. Germinated embryos were produced from all wheat × maize crosses, indicating that fertilization was successful. Eighty seven haploid green plants regenerated from the ninety six germinated embryos. This parameter actually indicates efficiency of embryo rescue operation. Regenerated plants were treated with colchicine and diploid plants were obtained. Twenty five haploid plants were treated with colchicine at 3 leaf stage but all are dead. After that Sixty two haploid plants were treated with colchicine at 5-6 leaf stage and sixty plants were survived. Colchicine treatment resulted diploidization and 96.77 percent of the total plants (62) were survived.

Pollination with maize pollens coupled with the post-pollination treatments proved effective in producing haploids and doubled haploids. The success in seed set obtained in this study was 83.24%. Percent of seed set represents the efficiency of emasculation and pollination procedures. The results demonstrated the effectiveness of the method to produce wheat plants from wheat × maize crossing. Colchicine treated plants are growing in the green house. Seeds might be produce from this colchicine treated plants if doubling of the haploid genome is successful.

Evaluation of wheat double haploid lines through wheat maize crosses

Sixteen Chinese double haploid lines and one double haploid line developed by WRC were evaluated along with two checks. The objective of this experiment was to evaluate the double haploid lines and to select the promising ones for Bangladesh environment. Seventeen double haploid lines with two checks of wheat namely Prodip and Shatabdi were conducted at RWRC, BARI, Joydebpur. The trial was shown on 26 November in Joydebpur and it was non replicated. The unit plot size was 2m long with 2 rows spaced at 20cm. Fertilizers were applied @ N100 P26 K50 S20 B1 kg ha^{-1}. All the fertilizers and two-third of urea were applied during final land preparation and one-third of urea was top dressed after first irrigation. All agronomic practices were done proper time for better yield performance. The data were recorded on Heading days (HD), Maturity days (MD), Plant height in cm (PH), Spike length in cm (Spk.Ln.), Number of grains per Spike (GR.SP), and 1000-grain weight (TGW) in grams. At maturity, thirty spikes were harvested to estimate grain yield.

The genotypes showed a wide range of variation for yield and others yield contributing characters studied. Twelve double haploid lines were matured earlier than the check variety Prodip. E 14, E 15 and E 17 were the earlier genotypes whereas E7 and E13 were late ones in comparison to the check variety Prodip. Eleven entries gave higher grain yield than the best check variety Prodip. E 12 had larger grain size, shorter vegetative growth period & maturity and also had highest grains per spike which made this genotype highest grain yielder among all. E 17 and E 1 yielded lower than the best check variety Prodip. On the basis of overall performance seventeen double haploid lines needed for further evaluation under different growing environment across the country. Based on overall performances and grain yield all double haploid lines will be further evaluated next year under different growing environment across the country.

Collaborative studies with international organizations

Ten international bread wheat nurseries and trials were conducted at different research stations of the Wheat Research Centre, BARI during 2016-17. The objective was to select promising lines on the basis of their yield potentiality, agronomic characteristics, disease reaction and physical grain quality. A total of 109 genotypes out of 1089 were selected from different international nurseries and trials. The selected genotypes will be further evaluated in different national nurseries and trials in next season.

Elite spring wheat yield trial (37th ESWYT)

Fifty elite wheat genotypes selected for mega-environment one and received through Cereal Systems Initiative for South Asia (CSISA) project of CIMMYT, Mexico were evaluated at the WRC, Dinajpur in alpha-lattice design. The genotypes were evaluated for yield, heading, maturity, plant height, number of grins per spike, 1000-grain weight, Bipolaris leaf blight, spike sterility tolerance, leaf rust resistance, physical grain characteristics etc. On the basis of overall performance E-104, E-105, E-120 and E-123 had selected for further evaluation in Bangladesh wheat screening nursery next year.

International bread wheat screening nursery (49th IBWSN)

Two hundred ninety four elite wheat genotypes selected for mega-environment one and received through CSISA project of CIMMYT, Mexico were evaluated at the WRC, Dinajpur in non-replicated trial. Widely used Shatabdi was used at each 25 genotypes interval starting from one. The genotypes were evaluated for yield, heading, plant height, Bipolaris leaf blight and spike sterility tolerance, leaf rust resistance, physical grain characteristics etc. On the basis of overall performance five genotypes were selected for further evaluation in heat tolerant wheat yield trial next year.

Heat Tolerant Wheat Yield Trial (15th HTWYT)

Forty nine genotypes selected by CIMMYT, Mexico for high temperature, irrigated environments were evaluated in a trial at WRC, Dinajpur, Joydebpur and RARS, Jessor under late seeding condition. WRC recommended management was followed to raise the crop. The genotypes were evaluated for yield, heading, plant height, Bipolaris leaf blight and spike sterility tolerance, leaf rust resistance, physical grain characteristics etc. Considering overall performances, five genotypes were selected for further evaluation in heat tolerant wheat yield trial next year.

Semi-arid wheat yield trial (24th SAWYT)

A field experiment was conducted as title “Semi-Arid Wheat Yield Trial (24th SAWYT) consisted of 50 advanced, high yield potential wheat lines provided by CIMMYT, Mexico included local check variety BARI Gom 30 at RWRC, Rajshahi during Rabi 2016-17 for evaluation yield potentiality under stress (drought) condition. The experiment was laid out in Alpha Lattice design with two replications. The genotypes were evaluated for yield, heading, Bipolaris leaf blight tolerance, sterility tolerance, visual grain quality, boldness of grains etc. On the basis visual grain performance and others yield contribution characters the nine genotypes (E-12, E-18, E-20, E-21, E-24, E-46, E-47, E-48 and E-49) were selected among the genotypes.

Semi-arid wheat screening nursery (34th SAWSN)

Two hundred and seventy two elite genotypes received from CIMMYT, Mexico were evaluated against the check variety BARI Gom 30 in RWRC Rajshahi during Rabi 2016-17. The plot size of the nursery was 2.5m long with 2 rows and the row distance was 20 cm. The genotypes were evaluated for yield, heading, Bipolaris leaf blight tolerance, leaf rust resistance, sterility tolerance, visual grain quality, boldness of grains etc. On the basis of visual grain quality, yield contributing traits and others agronomical performances only thirty two genotypes (E-3017, E-3021, E-3036, E-3040, E-3054, E-3063, E-3070, E-3083, E-3086, E-3087, E-3090, E-3092, E-3120, E-3122, E-3151, E-3159 ,E-3160, E-3167, E-3171, E-3190, E-3217, E-3226, E-3232, E-3236, E-3239, E-3247, E-3248, E-3252, E-3256, E-3261, E-3269, E- 3270 = 32) were selected from RWRC, Rajshahi for further evaluation.

Wheat yield consortium yield trial (4th WYCYT)

In order to develop pre breeding wheat materials, CIMMYT initiated consortium approach in plant breeding. Using all information available on photosynthetic and partitioning traits, CIMMYT desined hybridization schemes to combine physiological traits (PTs) with the view to achieving cumulative gene action for yield potential. These approaches have recently delivered new germplasm that expressed both higher yield and biomass compared to local checks grown at the majority of international sites where they were tested. In order to develop pre-breeding wheat materials, CIMMYT initiated consortium approach in plant breeding. The trial was consisted of 30 entries including one check variety Shatabdi. The experiment was sown on 24 November, 2016 at Dinajpur and on 24 November, 2016 at Joydebpur. The experiment was laid out in 5 x 6 Alpha-lattice designs with two replications. The unit plot size was 5m long 6 rows spaced at 20 cm and 40 cm between rows and entries respectively.

The selected two genotypes headed and matured later than the check variety Shatabdi. The highest yield was recorded in local check, E-22 (4045 kg ha^{-1}) followed by E-26 (4028 kg ha^{-1}). The lowest yield was achieved in E-15. Plant height of the selected entries was lower to Shatabdi. The 1000-grain weights of all the selected entries were lower than Shatabdi but their filling was good. Agronomic scores given by visual observation of E-21 and E-23 were close to Shatabdi. Significant variation among the genotypes, locations and their interaction was observed for all traits. None of the selected genotypes had earlier days to heading and days to maturity than Shatabdi at both locations. The E-6 had higher thousand grain weight than the check at Dinajpur and E-11 at Rajshahi locations but poor grain quality. Both of the selected entries obtained lower TGW than check variety. E-19 produced higher grain yield (4423kg ha^{-1}) than the check at Dinajpur. E-8 produced highest grain yield (3472 kg ha^{-1}) at Joydebpur. Based on different yield contributing characters and yield performance and visual grain quality 2 genotypes (E-19 and E-21) were selected for further evaluation.

Stress adaptive trait yield nursery (6th SATYN)

Stress Adaptive Trait Yield Nursery (SATYN) constituting lines selected from genetic resource collections that show favourable expression of heat adaptive traits. The nursery consists of 27 genotypes was tested at WRC, Dinajpur; RWRC, Joydebpur, Gazipur and RWRC, Rajshahi. The nursery was shown on 22 December in Dinajpur and 21 December in Rajshahi. Due to storm and rain, trial of Joydebpur was destroyed and no record was found. The experiment was laid out in Alpha-lattice design with two replications. The unit plot size was 2.5m long with 6 rows spaced at 20cm. Considering yield and other yield contributing characters along with different morpho-physiological traits five genotypes viz. E-16, E-20, E-23, E-25 and E-27 were selected for further evaluation.

Harvest plus yield trial (7th HPYT)

Fifty zinc enrich wheat genotypes from CIMMYT including check Variety Shatabdi were evaluated at Dinajpur, Joydebpur and Rajshahi during 2016-17. Genotypes were tested for enriched micronutrient (Zn) concentration, different physiological traits related to heat tolerance and high yield potential under irrigated time seeding (ITS) condition. The experimental design was alpha lattice design with 2 replications. Significant variation was observed for all of the traits studied. Considering different phonological & physiological traits; seed quality, Zinc content and yield potential 10 genotypes E -17, E-18, E-19, E-24, E-25, E-26, E-32, E-48, E-49 and E-50 have been selected for further evaluation.

HarvestPlus South Asia nursery (8h HPAN)

Two hundred elite genotypes received from CIMMYT, Mexico were evaluated in Dinajpur during Rabi 2016-17. The plot size of the nursery was 2.5m long with 2 rows and the row distance was 20 cm. The genotypes were evaluated for yield, heading, Bipolaris leaf blight tolerance, leaf rust resistance, sterility tolerance, visual grain quality, boldness of grains etc. On the basis of visual grain quality, yield contributing traits and others agronomical performances only eleven genotypes (E-13, E-31, E-42, E-43, E-55, E-61, E-72, E-81, E-122, E-144 and E-153) were selected from for further evaluation.

International durum screening nursery (48th IDSN)

International durum nurseries and trials from CIMMYT are the main source of durum germplasm in Bangladesh. The trial, received from CIMMYT, Mexico, was conducted to select superior durum germplasm with higher grain yields under irrigated condition for inclusion in Yield Trial next year. One hundred sixty-three entries from CIMMYT along with BDW 8 as local check were evaluated at WRC, Nashipur, Dinajpur, during rabi 2016-17. Performances of several durum lines were satisfactory compared to check BDW 8. The maximum thousand-grain weight (60.8 g) was recorded in E-7012 followed by E-7147 (60.1 g). On the basis of field performance, disease reaction, grain physical characteristics, and yield, twenty six durum lines viz. entry E-7008, E-7012, E-7026, E-7033, E-7035, E-7039, E-7044, E-7046, E-7047, E-7057, E-7060, E-7061, E-7073, E-7075, E-7120, E-7121, E-7130, E-7135, E-7137, E-7140, E-7144, E-7146, E-7147, E-7150, E-7151 and E-7158 were selected for further evaluation over environments. The grains of the selected durum entries were of acceptable quality and free from yellow berry marking. International durum yield nursery (47th IDYN)

PVS mother and baby trials and informal seed dissemination

Participatory research was conducted at the farmers' fields of Dinajpur, Rajshahi, Jamalpur, Jessore and Tangail to facilitate farmers in selecting their preferable varieties and disseminating seeds of those in noble ways. Researches were conducted as mother and baby trials under farmers' management with the help of focus group discussion, evaluation workshops, trainings and frequent interactions. Farmers' overall score at physiological maturity stage was the highest for BAW 1260 followed by BAW 1203. Farmers' chose these genotypes for its longer spike and higher expected yield. The highest overall score after harvest was recorded for BAW 1203 followed by BAW 1260 due to their bold shinny grains with higher yields. Overall, BAW1203 and BAW 1260 were the highest preferred genotypes over locations. In baby trials, BAW 1208 and BAW 1203 produced higher mean yields than the check variety Shatabdi and BARI Gom 28 and the line BAW 1122 produced the lower yields than the checks over locations.

Durum yield trial (DYT)

Twelve durum lines along with BDW 8, Morocco 2 and BARI Gom 29 as checks were evaluated at Wheat Research Centre, Dinajpur in rabi 2016-17. Significant variations were observed among the entries for plant height, grains/spike, thousand grain weight and yield. Only E-09 of the test entries yielded more than the check BDW 8 which was at per Morocco 2 and none one yielded over the wheat check BARI Gom 29. The highest grain yield was obtained from the wheat check BARI Gom 29 (4500 kg ha^{-1}) followed by the E-09 and Morocco 2 (4292 kg ha^{-1}). Thousand grain-weights of only four test durum entries (E-05, E-09, E-13 & E-14) were more than that of BDW 8 but lower than Morocco 2 (51.77 g). Grains of most of the durum lines were with yellow berry marking. On the basis of field performance, disease reaction, grain physical characteristics and yield, only four promising durum entries viz. E-04, E-05, E-09 and E-13 were selected for further study over locations.

Adaptive trial with advanced durum lines

After identifying promising durum lines with higher yield and quality in yield trials, it is important to evaluate these lines further in different agro-ecological zones under farmers' conditions. This trial facilitates to show the better performance of promising durum lines as compared to check to the farmers. It also helps National Seed Board (NSB) evaluation committee to evaluate the lines for recommendation to release them as varieties. So, this trial will be conducted at Multi Location Testing (MLT) sites with advance durum lines to evaluate and show their performance to farmers and NSB committee members. To evaluate yield performances of new durum lines in comparison to the check in different agro-ecological zones.

Four advance durum lines along with two durum checks were evaluated at WRC, Dinajpur during rabi 2016-17. Significant variations were observed among the entries for plant height, spikes/m2, thousand grain weight and yield. The highest (52.7 g) thousand-grains weight was also recorded in Morocco 2 and the lowest (45.5 g) in BDW 69. Among the entries BDW 73 was taller (plant height 96.7 cm) than others. The highest yield (4574 kg ha^{-1}) was obtained from BDW 73 and the lowest yield (4037 kg ha^{-1}) from BDW 8. The grains of most of the durum entries were of acceptable quality and free from yellow berry marking. On the basis of field performance, disease reaction, grain physical characteristics and yield, only two promising durum entries viz. BDW 70 and BDW 73 were selected for further study.

Triticale yield trial (TYT)

Triticale (X *Triticosecale*) is a hybrid of durum wheat (*Triticum durum*) and rye (*Secale cereale*) first bred in laboratories during the late 19th century. As a rule, triticale combines the high yield potential and good grain quality of wheat with the disease and environmental tolerance of rye. It is a useful dual-purpose crop for grain and forage biomass.

Six promising triticale lines along with four checks namely, BARI Triticale 1, BARI Triticale 2, WRF 7 and BAT 1 were evaluated at Wheat Research Centre, Dinajpur in rabi 2016-17. Significant variations were observed among the entries for thousand grain weight only. The highest (50.0 g) thousand-grain weight was also recorded in E-06 and the lowest (43.0 g) in BAT 1. The mean grain yield of E-07 (5042 kg ha^{-1}) was high among all but it’s grain was smaller and shriveled. Grains of most of the promising triticale entries were of acceptable quality. On the basis of field performance, disease reaction, grain physical characteristics and yield, only three triticale entries viz. E-06, E-09 and E-10 were selected for further study over locations.

Variety maintenance and breeder seed production

Variety maintenance and breeder seed production programme of Wheat Research Center is running based on the conception of pure line theory. The main objective of this programme is to maintain purity as well as to produce standard quality of breeder seed of cultivated varieties in order to supply a handful quantity to BADC and some NGOs. In 2016-17, five bread wheat varieties namely BARI Gom 25, BARI Gom 26, BARI Gom 28, BARI Gom 29 and BARI Gom 30 were maintained in first year line and second year line at WRC, Nashipur, Dinajpur. In the first year lines, 50/25 rows out of 200/100 were selected and harvested and threshed separately to form the source seed of the second year lines for next season. From the second year lines, a total quantity of 2118 kg seed from the selected plots of five varieties were produced and these will be sown in next season for breeder seed production in around 21 ha and the 877 kg seed from the remaining plots other than the selected ones will be used for truthfully labeled seed production.

Seeds of second year line of previous season (2015-16) of the varieties BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29 and BARI Gom 30 were grown in large plots at WRC, Nashipur, WRSS, Thakurgaon and WRSS, Debiganj during rabi 2016-17. A total of 56197 kg breeder seed of BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29 and BARI Gom

30 were produced in WRC during 2016-17 growing season. At the commencement of last growing season, a total of 51015 kg breeder seed was distributed to BADC, NGO's & Private Seed Companies.

Zn-enrich wheat yield trial (3rd ZnWYT)

Twenty-two zinc enrich wheat genotypes, selected from 6th HPYT and 7th HPAN along with check varieties Shatabdi, BARI Gom 25 and BARI Gom 26 were evaluated in the experimental field of WRC Dinajpur, RARS Jamalpur and RWRC, Joydebpur, Gazipur during the rabi season 2016-17. Genotypes were tested for enriched zinc concentration at CIMMYT, Mexico and selected for this study. The genotypes were grown under optimum and late sowing condition with three irrigations. The experimental design was 5 × 5 alpha lattice design with 2 replications. Significant variations were observed for most of the traits studied in all three locations. Dinajpur was the most effective location for selecting genotypes based on yield and other yield contributing characters in this study. Considering earliness, good agronomic traits, seed quality, yield potential and Zn content six genotypes viz., E5, E6, E8, E13, E15 and E25 have been selected for further evaluation. The selected micronutrient enriched lines will be promoted to PYT for yield trial across location.

Screening wheat against salinity under field condition

The trial was conducted at MLT site, Kuakata, Patuakhali in the Rabi season of 2016-17 under farmers' field condition. In the study, 16 wheat varieties/lines i.e. E1, E2, E3, E4, E5,E6, E7, E8, E9, E10, E11, E12, E13, E14, E15 and E16 were used. The experiment was laid out in RCB design with four replications having unit plot size 2.5 m with 4 rows. Seeds were sown on 12 December 2016 and harvested was done 24 March 2017. Statistically significant difference was found in all parameters . E7 gave the highest grain yield (3.49 t ha^{-1}) followed by E2 (3.2 t/ha). This might be happened due to higher number of plant population m^{-2} than that of other varieties and E5 produced the lowest grain yield (2.06 t ha^{-1}). Number of spike/plant, number of grains/spike, spike length and 1000-grain weight was the highest in E7. Salinity of the trail plots increased with time and it ranges 2.01 to 9.4 in the whole growing period. It was found that E7 is more salt tolerant in terms of yield fallowed by E2, E8 and E1.

Cultural Practices

Long-term effect of zero tillage on soil properties and productivity of wheat-mungbean-rice cropping pattern

An investigation was made in a long-term trial with conservation agriculture in wheat-mungbean-rice (*Aman*) cropping pattern started from rabi of 2005-06 in Research Farm of WRC, Nashipur, Dinajpur. There were 3 plots in each replication and two were assigned to zero tillage for all the 3 crops of the pattern. From 2008-09, one of the 2 zero-till plots were assigned to alternate tillage i.e., zero tillage for wheat and mungbean and then made conventionally puddled for *Aman* rice. Higher or at par wheat grain yields were obtained from permanent zero tillage than from conventional or alternate tillage up to 2016-17. Zero tillage or alternate tillage produced lower grain yields of mungbean, but higher biomass than conventional tillage. Grain yields of *Aman* rice was higher or at par in conventional tillage than in permanent zero tillage, but alternate tillage produced higher rice grain yields than zero or conventional tillage. Comparable total yields of the pattern (system yields) and rice equivalent yields were found in alternate tillage with conventional tillage. Improved soil chemical properties were found in long-term permanent zero tillage.

Long-term effect of different tillage options and residue retention for sustainable crop production in wheat-mungbean-rice copping pattern

The experiment was conducted to study the productivity and soil fertility using an intensified rice-wheat (R-W) system by adding a third pre-rice crop of mungbean. The trial comprises five packages of practices including crop residue retention, seeding methods with tillage options imposed on the component crops in wheat-mungbean-rice cropping pattern. The results indicated that keeping standing 30% crop residue in the field with minimum disturbance of soil had significant contribution to grain yield in wheat-mungbean-rice cropping pattern compared to conventional practice of well-till. System productivity and fertility were evaluated under five levels of tillage options (zero, strip, raised bed, Power Tiller Operated Seeder (PTOS) and conventional tillage practice in this cropping pattern. Raised bed and strip till with 30% straw retention produced highest productivity and lowest yield was found in conventional practice with 30% straw retention. Long-term trial is essential to see the effect on soil properties and sustainable issue of residue retention.

Long-term bed planting trial for improving productivity and fertility in wheat-mungbean-rice cropping pattern

A thirteen years long term bed planting field experiment was conducted to study the productivity, soil fertility and N-use efficiency of intensified RW systems by adding a third pre-rice crop of mungbean. System productivity, fertility and N use efficiency were evaluated under five N fertilizer levels (0, 40, 80, 100 and 120 % N of recommended dose, two straw retention (SR) (0 and 30%) and two tillage options (raised bed and conventional tillage practice (CTP). Permanent beds with 30% straw retention produced the highest productivity for all three crops in the sequence. Within each N rate the total system (rice-wheat-mungbean) productivity was higher with 30% SR on PRB and least in CTP with 0% SR. At 80% of recommended fertilizer N rate, mean annual system productivity was 12.5 t/ha for PRB with 30% SR, 11.2 t/ha with PRB on 0% SR and 10.3 t/ha with CTP without straw. N uptake and use efficiency were increased with increasing N levels with bed planting up to 120% N application (120 kg N ha^{-1}) in wheat, both 100% (80 kg N ha^{-1}) in rice and (20 kg N ha^{-1}) in mungbean for all years. System productivity in N unfertilized plots increased when straw was retained due to increased supply and uptake of N. The results suggest that N fertilizer rates can be reduced when 30% straw is retained both from rice and wheat & full residue retention from mungbean. Soil organic matter in surface soil layers of the PRB had increased by 0.78% after thirteen years (13 rice-wheat-mungbean crop cycles) with 30% SR. Straw retention is an important component of soil management and may have long term positive impacts on soil quality compared with conventional tillage with 0% SR. The combination of PRB with nutrients and residues retained appears to be a very promising technology for sustainable intensification of RW systems in Bangladesh.

Effect of bed planting and residue management on productivity of wheat-maize-rice cropping pattern

The experiment was conducted to study the productivity and soil fertility of intensified rice-wheat (RW) systems by adding a third pre-rice crop of maize. The trial comprises four packages of practices including crop residue retention, seeding methods with tillage options imposed on the component crops in wheat-maize-rice cropping pattern. The results indicated that keeping standing 30% crop residue in the field with minimum disturbance of soil had significant contribution on grain yield of wheat-maize-rice sequence compare to conventional practice of well-till without crop residue retention. System productivity and fertility were evaluated under two levels of straw retention (0 and 30%) and three tillage options (permanent raised bed, fresh bed and conventional tillage practice (CTP) in a RW- Maize cropping pattern. Both fresh and permanent bed with 30% straw retention produced highest productivity and lowest yield was also found from conventional practice with 0% straw retention. So, need long term effect for soil properties and sustainable issue of residue retention in drought prone areas of Bangladesh.

Evaluation of new wheat genotypes under different tillage methods using participatory technology selection approach

The experiment was conducted in WRC, Nashipur, Dinajpur during 2016-17 to observe the performance of newly wheat genotypes under different tillage methods using participatory technology selection approach. Treatments were three tillage options (bed, strip and PTOS) and six wheat genotypes (5 varieties: BARI Gom 26, BARI Gom 27, BARI Gom 28, BARI Gom 29, BARI Gom 30 and one advance line: BAW 1170). Treatments were arranged in split plots design with three replications i.e., tillage options were in main plots and genotypes were in subplots. From the result of the study indicated that the genotypes, BARI Gom 29 gave the highest grain yield in all tillage condition, followed by BARI Gom 30, BARI Gom 26, and BARI Gom 28 and BARI Gom 27 produced the lowest grain yield in all tillage conditions. Considering on tillage options, the strip was the best option for all wheat genotypes, followed by bed planting and PTOS. Considering on combine effect of tillage options and genotypes, the maximum grain yield was found from BARI Gom 29 under strip till condition, followed by BARI Gom 30 in same till condition.

Adjustment of seed rate for Zn-enriched promising line BAW 1260

The experiment was conducted at two locations (Gazipur and Dinajpur) during *rabi* season (November 2016-March 2017). The experiment was laid out with five seed rates, v.z. T_1= 120 Kg/ha (Recommended/as control), T_2= 130 Kg/ha (8 % more than recommended), T_3= 140 Kg/ha (17 % more than recommended), T_4= 150 kg/ha (25 % more than recommended) and T_5= 160 Kg/ha (33 % more recommended), in a randomized complete block design with three replications. The highest grain yield (combined grain yield over two locations) (5.21 t/ha) was obtain from both the treatments i.e. 140 kg/ha and 150 kg/ha seed rate were used in Zn enriched advanced line BAW 1260. Maximum BCR was calculated from both the treatments also and almost gave similar results 140 kg/ha (1.32) and 150 kg/ha (1.31). Maximum MBCR (over recommended/control) (19.44) was calculated from the treatment when 140 kg/ha seed rate was used in the experiment.

Development of yield model of modern wheat varieties under late sown heat stress environment

The trial was carried out in the Rabi season of two years of 2014-15 and 2015-16 in research field of Regional Wheat Research Centre, Rajshahi of Bangladesh Agricultural Research Institute. Four varieties *viz*., BARI Gom 26, BARI Gom 27, BARI Gom 28 and BARI Gom 29 of wheat were used as test crop. One irrigated timely sowing (ITS) and three irrigated late sowings (ILS) times were tested over heat stress condition. The ITS was Nov 25 and three ILS were Dec 10, Dec 25 and Jan 10, respectively. The design followed for the trial was split-plot with 3-replications. In case of late seeding, the genotypes phased a significant level of high temperature stress that also significantly affected the required days to anthesis, maturity of all genotypes including the yield and TGW as compared to irrigated timely sowing. In the timely sowing treatment, days to anthesis decreased due to late sown heat stress condition regardless the cultivars. These phenological characteristics under heat stressed condition led the wheat cultivars to significantly lower the grain yield as compared to normal condition. In late sowing conditions (Dec 10 –Jan 10), the grain yield was reduced by 8.9-32.5 % in BARI Gom 26, 9.6-36.3% in BARI Gom 29, 11.0-30.5% in BARI Gom 28 and 6.7-37.0% in BARI Gom 27. It was also observed that grain yield was found to be reduced by about by 4.3-14.2% in BARI Gom 26, 8.1-21.9 % in BARI Gom 27, 4.2-13.4% in BARI Gom 28 and 6.5-16.3% in BARI Gom 29from irrigated timely sowing condition (ITS) for each 1°C rise in average mean air temperature during booting to maturity (Table 10). On the other hand, reduction percent were less for the advanced lines and new varieties. Grain yield reduction was about (-) 1.4-2.65% in BARI Gom 28, 0.2.16.7 % in BARI Gom 27 and 1.7-6.0% in BARI Gom 29. Input variables of agro-climate (HDDS, RH, SSH, PR) and crop factors data are calculated and summarized for crop modeling.

Sowing dates trial of wheat for APSIM model

The study was conducted in Wheat Research Center, Nashipur, Dinajpur. The aim of the present study is to achieve cold temperature damage and also terminal heat stress for calibration and validation of APSIM model response for wheat crops. Treatments were: 7 sowing dates and 6 recently released wheat varieties. Sowing times were arranged in main plots and varieties were in sub-plots. Each APSIM wheat variety was calibrated using the field data from year 2014-15 then tested for validity using the field data from 2015-16. The APSIM model, as currently calibrated for this experiment, meets the usual accepted criteria for use in subsequent scenario analyses. That is, the RMSE between simulated and observed values is around the same quantum as the standard deviation across the experimental replicates (ideally lower, which ours are). The student's t-test also indicates no significant difference between observed and simulated values at a 95% confidence limit. But clearly the APSIM performance can be improved with better calibration, and possibly model science improvement – particularly indicated in simulation of wheat crop phenology at the earliest and latest sowing dates, and in biomass partitioning. This presented analysis should be regarded as a first-pass attempt at APSIM modeling this trial, and it is expected that great gains in model performance will be achieved following a more rigorous investigation of c*aus*es for model behaviours (will be conducted in collaboration with Dr Neil Huth, the developer of the APSIM-wheat module). So for now, the following simulated scenarios are essentially demonstrating the model capability, and will provide reasonably sensible answers, however will be refined as we further improve the APSIM calibration for this experiment and possible also improve some aspects of the model science concurrently. Scenario analysis: following acceptable model validation, longer-term historical climate data was then supplied to the APSIM model, and simulations performed for two scenarios: historical (using BMD data for Dinajpur, 1997-2013) and future climate (2060 A2 projection for Dinajpur).The performance of Shatabdi and BARI Gom 27 are compared for these two scenarios, for each of the experimental sowing dates. Grain yield and biomass were simulated (dry, 0% moisture).Simulations of climate change by 2060 (A2 is a fairly harsh projection) indicates no significant decreases in grain yield are likely for this location for these varieties. There is some evidence that the optimal sowing date for these varieties may move later in future climates. Later-sown crops exhibit higher season-season variability than earlier sown crops, and the grain yield simulations indicate that this trend could be even greater in future climates.

Effect of different nitrogen doses on grain protein content and yield of wheat

The experiment was conducted at two locations (Gazipur and Dinajpur) during *rabi* season (November 2016-March 2017). The experiment was laid out with six nitrogen levels, v.z. T1 =100 kg/ha (WRC recommended), T2 =125 kg/ha, T3 =150 kg/ha, T4 =175 kg/ha, T5 =200 kg/ha and T6=0 kg/ha (Control, initial soil status) nitrogen (N) in a randomized complete block design with three replications. The objective(s) of the experiment were i) to study the effect of nitrogen on protein content of wheat grain ii) to study the effect of nitrogen on grain yield of wheat. Considering combined analysis data, in respect of location effect, the highest grain protein content was measured (12.94%) at Gazipur location than Dinajpur location (10.80%), while the highest grain yield (4.52 t/ha) was obtained from Dinajpur location than Gazipur (4.05 t/ha). In case of N effect, 200 kg/ha N gave the highest grain yield (4.99 t/ha) followed by 175 kg/ha (4.90 t/ha), 150 kg/ha N (4.87 t/ha), 125 kg/ha N (4.53 t/ha), 100 kg/ha N (4.29 t/ha). Similarly, 200 kg/ha N gave the highest grain protein content (13.63 %). Almost similar trend was observed in case of interaction effect between location and N doses, 200 kg/ha N gave the highest grain yield (5.59 t/ha) at Dinajpur location followed by 175 kg/ha N (5.40 t/ha) and 150 kg/ha N (5.17 t/ha). Similar trend was also observed, 200 kg/ha N gave the highest grain protein (15.00%) followed by 175 kg/ha (14.13%) at Gazipur location. In view of economics, 200 kg/ha N treatment gave maximum (BCR, 1.21) followed by 175 kg/ha N (1.20), 150 kg/ha N (1.20), 125 kg/ha N (1.13), and 100 kg/ha N (1.08). The highest MBCR was found in 100 kg/ha N (15.63).

Fertilizer management to boost up wheat yield under surface seeding

This experiment was conducted at RARS, Jessore during 2016-17 to find out the suitable fertilizer dose to boost up wheat yield under surface seeding condition. Early flowering occurs (56 days) in T_2 and T_4 treatments. The maximum days to heading was recorded in T_8 (61 days) *i.e.* control treatment. The maximum plant height was recorded in T_2 treatment 91 cm. followed by T_4 treatment. Maximum spikes m^{-2} (305 no.) was observed in T_2 treatment followed by T_1 and T_4 treatments. Height grains/spikewas recorded in T_2 treatment (38.3.) followed by T_4 treatment. The maximum 1000-grain weight (40.3g) was obtained from the treatment T_4 which was statistically similar to T_2 treatment. Highest grain yield and biomass yield were obtained from the treatment T_4 treatment which was statistically similar to treatment $T_{2.}$ Therefore treatment combination T_2 (125% chemical fertilizers of the recommend doses applied before seeding of wheat seeds as basal) i.e. 125 is-32.5-62.5-25-1.25 kg ha of N-P-K-S-zn-B is the best to boost up wheat yield under surface seeding condition.

On-farm evaluation of wheat varieties under limited irrigation in AEZ 22

An experiment was conducted in farmers' fields in AEZ 22 under Sherpur district during rabi 2014-15 and 2016-17 seasons. Irrigation had significant effect on yield and yield contributing characters of wheat varieties except grains/spike in 2016-17. The variety had also significant effect on all the traits. In 2016-17, maximum spikes/m^2 (286) was observed in BARI Gom 27 with one irrigation (at CRI stage) followed by BARI Gom 27 without irrigation. The highest TGW (51.5 g) was recorded in BARI Gom 25 with one irrigation followed by BARI Gom 26 and BARI Gom 28. BARI Gom 25 and 28 produced higher grain yields in both the seasons in both the irrigation level than other varieties.

Validation of wheat based cropping patterns in Jamalpur region

The experiment was conducted at Regional Agricultural Research Station, Jamalpur during 2014-2015 and 2015-16 to determine the profitability of the alternate cropping patterns. The alternate cropping patterns were Wheat-GM-T. *Aus*-T. *Aman*, Wheat-Mungbean-T. *Aman*, Potato-Wheat-Mungbean-T. *Aman*, and Wheat-Mungbean-T. *Aus*-T. *Aman* against farmers' existing pattern Wheat-Jute-T. *Aman*. In both the years highest wheat equivalent yield (14.37 and 14.81 t/ha) was found from Potato-Wheat-Mungbean-T. *Aman* cropping pattern over the existing pattern. Gross return, Gross margin and BCR were also the highest from this pattern for both the seasons. The result revealed that the alternate cropping pattern was agronomically and economically profitable than the existing pattern.

Interaction of environment and genotypes for promotion of wheat under climate change condition

This experiment was conducted during the period from November 2016 to March 2017 in the experimental field at four locations namely Regional wheat Research Station, Gazipur, RARS, Rahmathpur, Barishal; Regional wheat Research Station, Rajshahi and RARS, Jessore to identify the wheat varieties/ genotypes suitable under changed environment and adjust the cropping period of wheat for higher yield in Bangladesh. The experiment comprised of two factors of five sowing dates (10 November, 20 November, 30 November 10 December and 20 December) assigned in the main plots and six genotypes (BARI Gom 25, BARI Gom 26, BARI Gom 28, BARI Gom 30, BAW 1200 and BAW 1202) distributed in the sub-plots. The experiment was laid out in Split Plot Design with three replications where date of sowing was assigned in the main plot and Genotype was assigned in the sub-plot. It was evident from the results that morpho-physiological and yield contributing characters of wheat were significantly influenced by date of sowing and genotype and their interactions. Sowing at 10 November exhibited the highest grain yield (3756 kg/ha) and the lowest grain yield was observed from sowing at 20 December (2106 kg/ha). BARI Gom 28 performed the best (3164 kg/ha) considering the grain yield of genotype effect whereas BARI Gom 25 yielded the least (2955 kg/ha). The highest grain yield was observed by BAW1202 (3693 kg/ha) followed by BARI Gom 25 (3658 kg/ha) in Barishal location and lowest in Jessore location (BARIGom25, 2222kg/ha and BAW 1200, 2264 kg/ha.

Screening of wheat genotypes against salinity at seedling stage

An experiment was conducted at laboratory of Regional Wheat Research Centre, BARI, Gazipur from November 22 to January 22, 2017 to select the wheat genotypes tolerant to salt stress. Fifty wheat genotypes were evaluated under four salinity levels of solution namely i. control (tap water), ii. 4 dS m^{-1}, iii. 8 dS m^{-1} and iv. 12 dS m^{-1}. Salt solutions were made through diluting the sea water with tap water. Seawater was collected from the Bay of Bengal having about 40 dS m^{-1} EC. The experiment was carried out in a split-plot design comprising salinity levels including control as main treatments and wheat genotypes as sub treatment with three replications. A wide range of variation was found among the genotypes in the production of seedling dry weight in all treatments but wide range of variation in germination was found in higher salinity. Considering higher seedling dry weight and higher relative thirteen genotypes namely 1, 2, 3, 5, 6, 11, 14, 15, 16, 25, 26 and 46 were tolerant under 8 dS m^{-1} salinity level and considering higher seedling dry weight and higher relative four genotypes namely 1, 5, 25 and 46 were tolerant under 12 dS m^{-1} salinity level. Considering both the conditions four genotypes namely genotype 1, 5, 25 and 46 were salt tolerant.

Effect of elevated level of potassium on the yield of wheat in the coastal saline soils

An experiment was carried out at farmer’s field, Kuakata, Patuakhali, during rabi season 2016-17 to observe the effect of elevated level of K on yield of wheat. The experiment was laid out in factorial RCBD with three replications. Two wheat varieties and five K doses were used as treatments. BARI Gom 25 performed better than BARI Gom 28. Yield and yield attributes increased with increasing K doses. Highest K dose (125 kg K ha^{-1}) produced the highest grain yield (2778 kg ha^{-1}) among the K doses but is was statistically similar with recommended dose (50 kg ha^{-1}), though most of the yield attributes highest and dissimilar in the same dose. So, further study will be needed.

Crop nutrition

Yield potential of promising wheat genotypes through maximizing fertilizer application

The information of the yield potential of newly develop wheat varieties and promising lines might be useful to explore the varietal potential in maximizing wheat yield and to assist wheat breeding programme in selecting varieties with higher yield potentials. A field trail was conducted in three locations, in fine textured (Silty clay) soil of Bangladesh Agricultural Research Institute (BARI) Joydebpur, medium textured soil of Regional Wheat Research Centre, Rajshahi and light textured soil of Agriculture Research Station, Jamalpur during 2016-17. In this trail, the response of six wheat genotype was examined under four levels of high fertilizer doses starting from recommended dose (120 kg N, 30 kg P, 50 kg K, 20 kg S, 4.0 kg Zn and 1.5 kg B ha^{-1}). The four fertilizer treatments are recommended NPKSZnB fertilizers (RF), 150% of RF, 150% RF+ Cow-dung (CD) @ 5.0 t/ha and 150% RF+ CD @ 10.0 t/ha were applied in main plots and six wheat genotypes (BARI Gom-28, BARI Gom-29, BARI Gom-30, BARIGom-31, BARI Gom-32 and BAW 1182 were grown in the sub plots in split plot design. The size of each subplot was 5m X 2m. Fertilizers of N, P, K, S, Zn and B were applied as urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate (Mono-hydrate) and boric acid, respectively. All fertilizers including two-third urea were uniformly applied in the field during final land preparation. The rest of urea was top dressed at the crown root initiation (CRI) stage at 21 days after sowing (DAS). The experimental result showed that higher fertilizer level increased wheat grain yield by increasing number of spikes/m2, grains/spike and 1000-grain weight. Among the genotypes BARI Gom-32 performed higher yield in all locations that was statistical similar to BARI Gom-30. The yield response of wheat to higher dose of fertilizers was varied among the locations. Wheat grain yield was the maximum at Jamalpur followed by Rajshahi and Joydebpur. The yield of BARI Gom-32 and BARI Gom-30 were more stable over the locations and these two varieties were more responsive to higher dose of fertilizers.

Integrated soil and nutrient management to improve the productivity of wheat-maize- rice cropping system

A field experiment was conducted at the central research farm of Bangladesh Agricultural Research Institute, Gazipur to achieve improved and sustainable productivity of an intensive wheat-maize-rice cropping system through integrated soil and nutrient management. Four levels of soil managements were tested under four nutrient levels in split plot design starting with wheat crop grown in 2009-10 season. Yield and yield contributing characters of component crops in the system were measured following standard methods. To understand the treatment effect on crops some additional studies including soil moisture content, weed growth, growth analysis of roots were made duly. Also the chemical analysis of soils were carried out following standard methods to determine the nutrient contents in soil after each cropping cycle upon rice harvest. The result indicated that soil management treatment of straw mulching had significant effect on surface soil moisture content that contributed to stand establishment both for wheat and maize crop. Rice straw mulch application either in bed or flat soil conditions was equally effective in conserving initial soil moisture, enhancing wheat root development and reducing weed growth and thereby positively influenced number of spikes/m2and finally grain yield of wheat. Similarly, wheat straw mulch application contributed to cobs/m2and grain yield of maize mainly by influencing the hydraulic properties of the soil. However, neither nutrient management nor soil management levels alone could produce the maximum yield but the combination of recommended fertilizers with 5 t/ha cow-dung couple with rice straw mulch application in wheat and wheat straw mulch application in maize resulted in maximum yield of wheat and maize. Rice yield was the maximum under nutrient level of IPNS and was not further increased due to further increase in nutrient levels of recommended fertilizers plus 5 t/ha cow-dung. The different soil management treatments those imposed on wheat and maize crops had the similar residual effect on rice yield until 2013 (5th cropping cycle) and thereafter rice yield was significantly improved by the residual effect of soil management treatments.

Effect of conservation agricultural practices on soil fertility and productivity in wheat-maize-rice cropping system

The experiment was undertaken to evaluate the performance of wheat-maize-rice cropping system under different CA practices in order to identify the appropriate CA practice capable in improving system productivity. Another objective was to study the change in soil properties due to shifting from conventional to conservation agricultural practice.

The experiment was conducted at research farm of Bangladesh Agricultural Research Institute, Gazipur to evaluate the effect of different CA practices on wheat-maize-rice cropping system. The experiment comprises four packages of CA practice combining crop residue retention, use of bed planter, PTOS (power tiller operated seeder) and zero tillage options imposed and or super imposed on the component crops with in a wheat-maize-rice cropping system. Standing rice and wheat straw of 25 cm in height were retained in soil under conservation practice in bed and flat soil conditions. The result indicated that conservation practices of retaining crop residue with the minimum disturbance of soil have significant contribution on grain yield of wheat and maize compare to conventional tillage and without crop residue retention. Conservation practices either in bed or in flat soil conditions were equally effective in improving spikes/m2 of wheat and cobs/m of maize and thereby increased wheat and maize yield throughout the experimental periods. The residual effect of conservation practice those imposed in wheat and maize crop had the similar effect on the grain yield of rice up to the 3rdricecropin the cycle and thereafter from the 4th cropping cycle, rice yield was also improved in response to residual effect of conservation practices. The Chemical analysis of the soils of experimental plots in different years indicated that available nutrient contents in soil especially P (Olsen), K, S and B were improved when CA treatment was imposed either on bed or flat soil conditions. The six years study demonstrated that CA could contribute to soil fertility, plant growth and establishment and finally improved the yields of component crops.

Disease Management

Diseases are one of the major constraints to wheat production in Bangladesh. Among them, Bipolaris leaf blight (spot blotch) caused by *Bipolaris sorokiniana* (Sacc.) Shoemaker is most important. The disease occurs every year in all wheat growing areas of the country with varying degrees of severity depending on cultivar, sowing time and location. The second most important disease is leaf rust caused by Puccinia triticina Eriks. The disease usually appears in mid February under the agro-climatic condition of Bangladesh. It may cause severe yield losses if a susceptible variety is late sown and infection occurs early in the crop season. The popular variety Prodip has become susceptible to leaf rust and may be seriously affected under late sown condition. Stem rust caused by *P. graminis* Pers. *f. sp. tritici* Eriks. & Henn. was observed in 2014 and 2015 in the rust trap nurseries after three decades, but no Ug99 detected. Yellow rust caused by *P. striiformis* West. f. sp. tritici Eriks. & Henn. occurs occasionally with low to moderate severity. So far none of the rusts has reached an epidemic level in Bangladesh, but damaging epidemics may occur, particularly if a new virulent race develops or is introduced. Other diseases of regular occurrence are seedling blight caused by *B. sorokiniana*, foot and root rot caused by *Sclerotium rolfsii* Sacc., head blight caused by *B. sorokiniana* and black point incited mainly by *B. sorokiniana* and *Alternaria alternata* (Fr.) Keiss. However, head blight and black point were quite frequent in 2016-17. Powdery mildew caused by *Erysiphe graminis f. sp. tritici* has been observed since 2012 to 2015 in late February with sporadic infection, but the disease was not noticed in the last two crop cycles. Unfortunately, wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 5-100% with significant yield losses depending on cultivar and sowing times. The disease reappeared in 2017 and hence underlines the urgent need for research to mitigate the threat of this disease. Presently several collaborative programmes have been undertaken to find out integrated disease management solutions. Major research thrust included screening and evaluation for disease resistance, testing fungicidal efficacy, finding the role of sowing times, and disease surveillance and monitoring in national and international nurseries and farmers' fields.

Evaluation of wheat genotypes against Bipolaris leaf blight under inoculated condition

Bipolaris leaf blight (BpLB) caused by *Bipolaris sorokiniana* (teliomorph: *Cochliobolus sativus*) is the most important disease of wheat in Bangladesh for its nature of damage and wide occurrence throughout the country. Evaluation of varieties or lines against different diseases under inoculated condition is an essential pre-requisite towards development of resistant varieties. A total of 56 entries including susceptible and resistant checks were grown in 1m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries. The experiment was conducted at WRC, Dinajpur. Planting was done in the 1st week of December. Recommended agronomic practices were followed for normal crop growth. Plants were inoculated by spraying with conidial suspension (104 conidia/ml water) of 15-day-old PDA culture of *B. sorokiniana* after heading and incubated under polyethylene cover for 48 hr. Before covering, the plants were watered to maintain high humidity inside. Data on BpLB severity was recorded as percent diseased leaf area (% DLA) from 10 flag leaves of 10 main tillers selected randomly in each plot. Disease assessment was done after 25 days of inoculation. The genotypes and lines were graded for disease reaction based on % DLA.

Severity of BpLB expressed as % DLA on flag leaves varied greatly among the different lines and varieties tested under inoculated condition. The disease severities ranged from 5% in Milan/sha 7 and Chirya 7 to 83% in Kanchan, a highly susceptible variety. Based on the disease severity assessed on flag leaves, 2 lines were graded as resistant, 9 moderately resistant, 18 moderately susceptible, 22 susceptible and the rest 5 as highly susceptible. None of the lines and varieties was found free from BpLB infection. Out of 56 genotypes tested, 2 lines were graded as resistant, 9 moderately resistant, 18 moderately susceptible, 22 susceptible and the rest 5 as highly susceptible.

Evaluation of wheat germplasm against Bipolaris leaf blight

A total of 140 genotypes from different sources along with checks were evaluated against BpLB under field condition of disease development. The experiment was conducted in three locations-Dinajpur, Jamalpur and Jessore. The materials were planted in 2.5m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries in mid December/2016 under irrigated condition. The nursery was surrounded by spreader rows composed of mixture of susceptible varieties. The design of the experiment was Alpha Lattice with two replications. Recommended fertilizers and cultural practices were followed for normal crop growth. Leaf blight severity was scored three times on double digit scale (00-99) commencing from the water ripe to early dough. Disease data were converted to percent diseased leaf area (% DLA) and then area under disease progress curve (AUDPC) was calculated. Data on wheat blast were recorded in Jessore as percentage of spike infected and percentage of disease area on spike and converted to disease severity. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield. Out of 140 entries tested, 19 lines were selected based on AUDPC, % blast severity (recorded in Jessore), grain yield and other agronomic characters. The AUDPC of the selected lines ranged from 240 to 385, while those of the susceptible check varieties ranged from 259 to 493. Grain yields of the selected lines varied from 431 to 610 g/plot, whereas 457 to 534 g/plot were obtained from the susceptible check varieties. Blast severity of the selected entries recorded in Jessore varied from 0 to 0.72%. Days to heading, plant height and 1000-grain weight of the selected lines were also within acceptable limit as compared to the check varieties. Among the 140 entries evaluated, 19 lines were selected based on disease severity, 1000-grain weight, grain yield and other agronomic characters. The selected lines will be subjected to artificial inoculation in the next season for final evaluation.

Helminthosporium leaf blight screening nursery

Resistance to *Helminthosporium* leaf blight (Bipolaris leaf blight) caused by *Bipolaris sorokiniana* is limited in the cultivated wheat varieties of the Indo-Gangetic Plains of South Asia. The disease becomes more severe if the crop is lodged and rainfall occurs during grain filling period. Searching of resistant sources is, therefore, very essential in order to develop variety with good level of resistance and good agronomic types. The present study was undertaken to evaluate wheat lines from CIMMYT-Mexico for resistance to *Helminthosporium* leaf blight under natural conditions of disease development. The 8th Helminthosporium leaf blight screening nursery consisting of 52 wheat genotypes from CIMMYT including local check varieties were evaluated against spot blotch disease in three different locations-Dinajpur, Jamalpur and Jessore under natural infection. The materials were planted in 2.5 m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries. Planting was done in mid December/2016 under irrigated condition. The nursery was surrounded by spreaders rows of susceptible varieties such as Sonalika and CIANO-79, while the resistant variety Shatabdi and predominant variety Prodip were used to compare with test lines. Recommended fertilizers were applied and regular cultural practices were followed for normal crop growth. Spot blotch data were scored on double-digit scale (00-99) and converted to percent disease severity. Disease scoring was done three times commencing from the water ripe to early dough stage. The AUDPC was calculated. Wheat blast severity was recorded in Jessore as percentage of spike infected and percentage of disease area on spike. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield. The entries were scored on 0-5 scale for their general agronomy in the field. Out of 52 lines tested, 10 lines were selected based on AUDPC, % blast severity, 1000-grain weight, grain yield and other agronomic characters assessed in three locations. Among the selected lines, entry no. 15, 16, 19, 40, 41, 45 & 46 were selected in two locations and rest of them were from one location. The AUDPC of the selected lines ranged from 299 to 498, while those of the susceptible check varieties ranged from 520 to 568. Grain yields of the selected entries varied between 411 to 624 g/plot, whereas 383 to 414 g/plot were obtained from the susceptible check varieties. Blast severity of the selected entries recorded in Jessore varied from 0 to 1.8%. Days to heading, plant height and 1000-grain weight of the selected lines were within acceptable limit as compared to the check varieties. The agronomic score ranged from 3-4 among the selected lines. Among the 52 entries tested, 10 lines were selected based on disease severity, 1000-grain weight, grain yield and other agronomic characters. The selected lines will be included in the heat tolerant screening nursery and subjected to artificial inoculation for final evaluation and use in the hybridization scheme in order to develop genetic diversity of Helminthosporium leaf blight resistance.

Stem rust resistance screening nursery

Stem rust caused by *Puccinia graminis* f. sp. *tritici* is an important disease of wheat worldwide. In Bangladesh, the disease was not observed in the last three decades, but recently in 2014 it was detected in some entries of the rust trap nurseries. So, this is not unlikely that the disease will appear on a large scale in future and cause damage to wheat. CIMMYT has developed wheat germplasm with good level of stem rust resistance and high yield potential. The materials were distributed worldwide through Stem Rust Resistance Screening Nursery (SRRSN) for direct release or use in breeding programmers to mitigate the threat of stem rust. The present study was undertaken with the objectives to evaluate the lines of the 11th SRRSN consisting of 171 wheat entries from CIMMYT including local check varieties were evaluated for disease response, yield and other agronomic performances. The materials were planted in 2.5 m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries in the mid December in three different locations-Dinajpur, Jamalpur and Jessore. The nursery was surrounded by spreaders rows of susceptible varieties. Recommended fertilizers were applied and regular agronomic practices were followed for normal crop growth. Stem rust was not noticed over locations. Severity of BpLB was scored on double-digit scale (00-99) and converted to percent diseased leaf area (% DLA) and AUDPC was calculated. Wheat blast severity was recorded in Jessore as percentage of spike infected and percentage of disease area on spike. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield. Agronomic score (0-5) was given to individual entries for their general agronomy in the field. Among the 171 entries tested, 13 lines were selected on the basis of BpLB severity (AUDPC), % blast severity, 1000-grain weight, grain yield and other agronomic characters assessed over locations. Among the selected lines, entry no. 6013, 6017, 6083, 6098 and 6105 were selected in two locations, while the others were selected from one location. Stem rust was not noticed over locations. AUDPC of the selected lines ranged from 221 to 436, while the check varieties showed the AUDPC value 239 to 548. Grain yields of the selected entries varied from 409 to 618 g/plot, whereas 515 to 602 g/plot were obtained from the check varieties. Blast severity of the selected entries recorded in Jessore varied from 0 to 0.6%. Days to heading, plant height and 1000-grain weight of the selected lines were within acceptable limit as compared to the check varieties. The agronomic score was 3 out of 5 for majority of the selected lines.

Among the 171 entries tested, we have selected only 13 lines based on disease severity, 1000-grain weight, grain yield and other agronomic characters. The selected lines will be included in national nurseries for further evaluation and use in hybridization scheme to develop genetic diversity of rust resistance.

Evaluation of wheat genotypes for resistance to leaf rust under inoculated condition

Leaf or brown rust caused by *Puccinia triticina* Eriks. is most important among three wheat rusts in Bangladesh. The disease occurs in all wheat growing areas of the country with varying levels of severity depending on cultivar, sowing times and locations. The disease usually appears in mid February with increasing severity between mid and late March. Late planted wheat is affected more than those planted in optimum times (15-30 November). Yield losses due to leaf rust are usually less than 10%, but can be 30% or more depending on the level of susceptibility, environmental conditions and the stage of crop development at the initial stage of infection. Under the agro-climatic conditions of Bangladesh, losses to leaf rust would be significant if a susceptible variety is grown under late sown condition. Use of resistant variety is the most dependable and economic approach for the control of rust diseases. Evaluation of breeding lines against different diseases under inoculated condition is an essential pre-requisite towards development of resistant varieties. The present experiment was designed to evaluate the response of the advanced wheat genotypes against leaf rust under inoculated condition. A total of 72 entries including resistant and susceptible checks were planted in 1m long 2-row plots with 20 cm spacing between rows and 30 cm between entries. The experiment was conducted in WRC, Dinajpur. Planting was done in last week of December. Susceptible variety Morocco was planted in two rows after each pair of test lines and the nursery was surrounded by spreader rows of susceptible varieties. Recommended agronomic practices were followed for normal crop growth. Test entries and spreader rows were inoculated by spraying with aqueous suspension of urediospores at booting stage of the crop. Disease assessment was done between early and soft dough stages using modified Cobb scale representing severity and infection types. Lines were graded into resistance category based on disease severity.

Severity of leaf rust varied among different lines and varieties were tested under inoculated condition. The advanced lines showed 0 to 50% severity with different types of disease response, while 90% severity with susceptible reaction was displayed in Morocco. The variety, BARI Gom 27 and BARI Gom 30 were completely free from leaf rust. Based on disease severity majority of the advanced lines were found resistant to moderately resistant. Among the advanced lines, 7 lines were completely free from leaf rust infection. Selected resistant lines will be further evaluated in 2017-18 wheat cycle for confirmation of resistance.

Assessment of yield losses due to leaf rust at different growth stages of wheat

Leaf rust caused by *Puccinia triticina* Eriks. is the second most important disease of wheat in Bangladesh. The disease usually appears in mid-February, and its severity is more in late than in optimum time planted crop. Yield losses of various degrees to this disease have been reported from home and abroad. However, the quantity of losses depends largely on the level of resistance and stage of crop development at the initial stage of infection. The popular wheat variety Prodip has become susceptible to leaf rust and is severely affected under late sown condition. Therefore, it is important to determine the losses caused to this variety due to leaf rust infection at various growth stages under different sowing dates.

The leaf rust susceptible variety Prodip and Morocco were sown at seven different dates. Sowing commenced from 23 Nov. 2016 with seven days intervals. One of the two plots of both varieties under each sowing date was protected from leaf rust by spraying with Tilt 250 EC and the other was kept unprotected. Split-split-plot design was followed with sowing dates in main plot, fungicide protection in sub-plot and varieties in sub-sub-plot. Unit plot size was 3 m x 1.6 m. The experiment was surrounded by spreader rows of susceptible varieties. Spreader rows were inoculated at booting stage by spraying with aqueous suspension of urediospores to develop leaf rust epidemic. Disease severity was recorded at different growth stages using modified Cobb scale. Data were also taken on 1000-grain weight and grain yield from both sprayed and unsprayed plots, and percent losses in these parameters were calculated under different sowing dates. Significant variations in leaf rust severity, 1000-grain weight and grain yield were observed for sowing date (A), fungicide protection (B) and variety (C). Interactions between different factors were also found significant for different variables except A x C and A × B x C for leaf rust severity, A x B and A x B x C for grain yield and A x C, B x C and A × B x C for 1000-grain Weight. Severity of leaf rust and losses in 1000-grain weight and grain yield varied between the varieties Prodip and Morocco used in the present investigation. Losses recorded in Morocco were higher than Prodip under late sown condition. In general, disease severity and losses in grain weight and yield were higher under late planted compared to timely planted condition. An increasing trend in losses in grain weight and yield was observed with the increase in delay of sowing. Leaf rust severity and losses in 1000-grain weight and grain yield increased with the increasing delay of sowing. Losses in grain weight and yield of Morocco were higher than Prodip under both optimum and late planting conditions.

Efficacy of fungicides in controlling Bipolaris leaf blight and leaf rust of wheat

Expression of resistance to Bipolaris leaf blight is less sustained under favourable conditions of disease development in the rice-wheat cropping systems. In absence of good level of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Leaf rust of wheat caused by *Puccinia triticina* Eriks., can also be controlled with foliar application of fungicides. Among many fungicides, Propiconazole and Tebuconazole were reported to be effective against both the diseases. The present work was undertaken to evaluate the efficacy of some new fungicides of different groups in controlling Bipolaris leaf blight and leaf rust of wheat under field condition.

Seven fungicides of different groups were tested for their efficacy against Bipolaris leaf blight and leaf rust of wheat. The fungicides Tilt 250 EC (Propiconazole), Folicur 250 EC (Tebuconazole) and Awal 72 WP (Zineb + Hexaconazole) were used as standard check, while the others Master Zeb 80 WP (Mancozeb), Positive 300 SE (Difenoconazole + Propiconazole), Sun-Fighter 25 SC (Hexaconazole + Tricyclazole) and Nativo 75 WG (Tebuconazole 50% + Trifloxystrobin 25%) were tested as new fungicides. The fungicides were sprayed twice, once at heading stage and another at 15 days after first spraying. An unsprayed control was maintained for comparison. The susceptible variety Kanchan was used for BpLB and Morocco for leaf rust. Seeds were sown in 1.2 x 2.5 m plots with 20 cm row-spacing on 19 December 2016. The experiment was laid out in RCB design with three replications. Recommended doses of fertilizers were used and three irrigations were applied during the crop cycle. Disease severity was scored as percent diseased leaf area (% DLA) on 10 flag leaves of 10 main tillers selected randomly in each plot. Severity of BpLB and leaf rust were scored. Data on grain yield per plot were recorded. Percent disease reduction and yield increase over unsprayed control were calculated. Among the seven fungicides tested against Bipolaris leaf blight, all were found very effective in controlling the disease. The lowest disease severity was recorded in the plots sprayed with Tilt 250 EC, Folicur 250 EC, Nativo 75 WG and Positive 300 SE, which was followed by Awal 72 WP, Sun-Fighter 25 SC and Master Zeb 80 WP. The unsprayed plot showed the highest disease severity. The percent disease reduction by the fungicides ranged from 93 to 99% over unsprayed plot. The highest grain yield was obtained with Nativo 75 WG, and the increase in yield by this fungicide over unsprayed control was 34%, which was followed by Tilt 250 EC, Folicur 250 EC, Master Zeb 80 WP, Awal 72 WP, Positive 300 SE and Sun-Fighter 25 SC. Significant control of leaf rust was observed with foliar sprays of the seven selected fungicides. The unsprayed plot showed the highest disease severity. Fully controlled of the disease was recorded with Tilt 250 EC, Folicur 250 EC, Awal 72 WP and Positive 300 SE, which was followed by Sun-Fighter 25 SC, Nativo 75 WG and Master Zeb 80 WP. The fungicides controlled the disease by 98 to 100% with 82 to 326% increase in grain yield over unsprayed plot. The highest increase in grain yield was obtained with Nativo 75 WG and Tilt 250 EC, which was followed by Folicur 250 EC, Positive 300 SE, Awal 72 WP, Sun-Fighter 25 SC and Master Zeb 80 WP. All the seven selected fungicides viz. Nativo 75 WG, Tilt 250 EC, Folicur 250 EC, Master Zeb 80 WP, Awal 72 WP, Positive 300 SE and Sun-Fighter 25 SC were found very effective in controlling Bipolaris leaf blight and leaf rust of wheat. These fungicides reduced Bipolaris leaf blight by 93 to 99% with 19 to 34% increase in grain yield and leaf rust by 98 to 100% with 82 to 326% yield increase.

Adaptation of wheat genotypes for tolerance to terminal heat stress and Bipolaris leaf blight

Bipolaris leaf blight or spot blotch caused by *Bipolaris sorokiniana* (teliomorph: *Cochliobolus sativus*) is the most important disease of wheat in Bangladesh for its nature of damage and wide occurrence throughout the country. Yield losses are significant and can be severe if wheat is grown under late sown condition when terminal heat stress aggravates the disease severity during grain filling stages of the crop. However, the degree of disease severity and yield losses depends on variety and growing condition. Moreover, new virulence may also appear, particularly under changing climate which may affect adaptation of cultivars to existing environments. The experiment was conducted at WRC Dinajpur and laid out in split-split plot design with two replications. Two sowing dates, 24 November (optimum) and 22 December (late) were taken as main plot, two fungicide protections i.e., protected and non-protected as sub-plot and 12 lines and varieties as sub-sub plot. The lines were BAW 1260, BAW 1208, BAW 1170, BAW 1222, BAW 1254, BAW 1194, BAW 1195, BAW 1202, BAW 1203 BAW 1243 and the varieties were Kanchan and Shatabdi. The unit plot size was 2.5m x 1.2 m (2.5m long 6 rows with 20 cm spacing. The crop was protected from BpLB disease by spraying with Tilt 250

EC, a Propiconazole fungicide. The fungicide was applied 3-4 times @ 1 ml/litre of water, commencing from 35-40 days after sowing at 12-15 days intervals. Disease severity was scored three times on double-digit scale (00-99) and converted to percent disease severity. The AUDPC was calculated. Agronomic data were recorded on days to heading, plant height, days to maturity, biomass, 1000-grain weight and grain yield. The harvested area was 2 m2 (2.5 m long 4 rows). Variations in disease severity (AUDPC) and grain yield were found significant for sowing date, fungicide protection and variety.

Significantly higher disease severity was observed in unsprayed plot compared to sprayed plot. Late sowing showed higher disease severity than timely sown condition. The variety Kanchan showed the highest disease severity under both the sowing dates. The lowest disease severity was recorded in Shatabdi, which was followed by BAW 1170. The other varieties exhibited more or less similar overall disease severity. Grain yield of wheat varied significantly among varieties and between fungicide protections. Grain yield was found highest in BAW 1202 followed by BAW 1208 and while the lowest grain yield was recorded in Kanchan. However, all the lines and varieties produced lower grain yields under late sown condition. The reduction in yield due to late planting was found lowest in BAW 1170 followed by BAW 1254 and highest in Kanchan followed by BAW 1260, BAW 1195 and Shatabdi. Yield loss due to Bipolaris leaf blight was found lowest in Shatabdi followed by BAW 1170 and BAW 1243, and the highest in Kanchan. The reduction in yield due to late planting and Bipolaris leaf blight together was found highest in Kanchan followed by BAW 1260, while the lowest was recorded in BAW 1170 followed by BAW 1222 and Shatabdi. However, the yield reduction due to late planting and Bipolaris leaf blight was more or less similar. In general, BpLB severity was higher and grain yield was lower under late planting compared to planting in optimum time. Application of fungicide significantly reduced disease severity resulting in higher yield compared to unprotected crop. The lowest disease severity was recorded in Shatabdi, which was followed by BAW 1170, while the highest disease severity was recorded in Kanchan under both the sowing dates. The reduction in grain yield due to late planting and BpLB disease varied among different varieties. However, the reduction due late planting was more or less similar to BpLB disease.

Wheat blast and rusts surveillance in Bangladesh

Wheat blast caused by *Pyricularia oryzae* (teliomorph: *Magnaporthe oryzae*) has been identified in Bangladesh for the first time in late February 2016 causing significant yield losses in several south-western and southern districts of the country. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. The disease was also noticed this year with low disease severity and about 5-10% yield loss occurred. Another important disease of wheat is rust that occurs worldwide. The tiny spores of rust pathogens are airborne in nature and can travel long distances often over continents. A new virulent race of stem rust called Ug99 was developed in Uganda in 1999 (Pretorius et al. 2000) and subsequently found in epidemic proportions in Kenya and Ethiopia. So far 14 different countries including Sudan, Yemen, Iran, South Africa and Egypt have been affected and 11 variants of the race detected. Although none of the rusts has so far reached an epidemic level in Bangladesh, but there is no guarantee that damaging epidemics will not occur in future, particularly if a virulent race develops or is introduced. Therefore, regular survey and monitoring becomes inevitable in order to identify signs of emergence of the virulent strains of wheat rust and blast.

Pathologists and breeders took part in monitoring of wheat rusts in farmers’ fields and trial sites. In case of wheat blast surveillance, a total of 24 districts were covered with 103 farmers’ fields and trial sites investigated in the major wheat growing areas of Bangladesh. The survey was conducted by during 7-15 Feb. 2017 with CIMMYT, USAID and ACIAR support. Forty wheat scientists from Bangladesh, Nepal and India along with BADC, DAE, BARC and relevant department personnel participated in the surveillance programme. The disease was assessed as % spike infection and % diseased area on spike based on 0-100 scale. In case of rust, a total of 102 fields of the major wheat growing areas were covered in the current season for rust survey (2016-17). The survey work was implemented collaborating different stations of WRC: Dinajpur, Joydebpur, Jessore, Jamalpur and Rajshahi. Disease assessment was made following the modified Cobb scale. The BGRI protocols and format were used during the present survey. Diseased specimens were collected in brown paper bags and brought to the laboratory of Wheat Research Centre for proper identification and confirmation.

2017 was comparatively less favourable year for wheat blast development as because of moderate temperature with no rain at the heading/flowering stage of wheat. However, late planted fields were infested with wheat blast with low to high disease severity. A total of 24 districts was surveyed which covered about 103 farmer's fields and trial sites. Out of 103 sites, 33 sites were infected with wheat blast, and among the infected sites, 77 fields were identified with the incidence of wheat blast. Districts of Bhola and Faridpur showed higher level of disease severity in late planting condition, although early planted field in those districts had escaped disease infection. The lowest level of disease infection was observed in Magura district. Overall disease incidence was comparatively lower with moderate disease severity.

Leaf rust was found in different wheat growing areas but with comparatively higher disease pressure than in previous years. About 52% of the 102 fields investigated had leaf rust. Among the infected fields, 73% showed low (<20%), 21% moderate (20-40%) and only 6% high (more than 40%) disease severity. Distribution of disease was uneven and infrequent. Timely (15-30 November) planted crops largely escaped or had less disease compared to late planted crops. Number of leaf rust infected fields was more in the north-western wheat growing areas compared to other parts of the country. The predominant cultivar Prodip as well as BARI Gom 25 and BARI Gom 26 showed zero to high disease levels with MSS type reactions. The unknown cultivar showed zero to moderate level of disease severity with MSS type of reaction, the varieties BARI Gom 28, BARI Gom 29, BARI Gom 30 and Shatabdi were free from leaf rust infection.

Stem rust or yellow rust was not found in any of the wheat growing areas surveyed. Yellow rust is infrequent in Bangladesh, but does occur occasionally with sporadic infection, particularly on susceptible variety Morocco. Wheat blast was noticed with comparatively lower severity than the previous year. Stem rust and yellow rust were not found, but leaf rust was observed mostly with low disease severities. This does not indicate that virulent races of blast and rust pathogens will not emerge and inflict severe damage in future. Therefore, disease survey and monitoring needs to be continued in order to adopt appropriate management approach to mitigate blast and rust epidemic. Breeding resistant varieties and quick replacement of the susceptible cultivars would be the most economic and dependable control strategy. As an interim measure, fungicide may be applied for crop protection if a susceptible variety is grown, particularly under late sown condition.

Evaluation of wheat germplasm against wheat blast under field condition

Wheat is the second most important cereal next to rice in Bangladesh and playing an important role in food security. The crop faces several abiotic and biotic stresses. Among the diseases, leaf blight, leaf rust, head blight and black point are usually common in the agro-climatic environment of the country. Unfortunately, wheat blast, a devastating wheat disease caused by *Pyricularia oryzae*, teliomorph: *Magnaporthe oryzae*, emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Breeding for resistance is the most economic and reliable approach to control the disease and therefore, it is very essential to screen available germplasm from different sources for resistance to this disease.

A total of 110 genotypes from different sources along with checks were evaluated against wheat blast under field condition of disease development. The experiment was conducted in two locations-Dinajpur and Jessore. The materials were planted in 2.5m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries in mid November and mid December/2016 in ITS (Irrigated Timely Sowing) and ILS (Irrigated Late Sowing) condition. The nursery was surrounded by spreader rows composed of mixture of susceptible varieties. The design of the experiment was Alpha Lattice with two replications. Recommended fertilizers and cultural practices were followed for normal crop growth. Wheat blast severity was recorded in Jessore as percentage of spike infected and percentage of disease area on spike and converted to percent disease severity. Leaf blight severity was scored on double digit scale (00-99) at early dough stage. Disease data were converted to percent disease severity. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield.

Out of 110 entries tested, 10 lines were selected based on % blast severity, % BpLB severity, grain yield and other agronomic characters. Among the selected lines, entry no. 12, 13, 44, 55, 75, 83 and 109 were selected in two locations, while the others were selected from one location. Percentage of disease severity of the selected lines ranged from 0 to 1.8%, while those of the check varieties ranged from 4.1 to 76.5%. Percentage of spike incidence as well as diseased area on spike was higher on BARI Gom 26 (most susceptible variety of wheat blast). Among the selected lines, 6 lines were completely free from blast infection. Percent BpLB severity of the selected entries recorded varied from 31 to 56. Grain yields of the selected entries varied from 432 to 621 g/plot, whereas 466 to 530 g/plot were obtained from the susceptible check varieties. Days to heading, plant height and 1000-grain weight of the selected lines were also within acceptable limit as compared to the check varieties. Among the 110 entries evaluated, 10 lines were selected based on disease severity, 1000-grain weight, grain yield and other agronomic characters. The selected lines will be subjected to artificial inoculation in the next season for final evaluation.

Efficacy of foliar fungicides in controlling wheat blast

Wheat blast, a devastating wheat disease caused by ascomycetous fungus *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Among many fungicides Tebuconazole, Tryfloxystrobin and Trycyclazole were reported to be very effective against the disease. The present work was undertaken to evaluate the efficacy of foliar fungicides in controlling wheat blast under field condition. Five fungicides of different groups were tested for their efficacy against wheat blast. The fungicides Nativo 75 WG (Tebunaconazole 50% + Trifloxystrobin 25%), Amistar Top 325 SC (Azoxystrobin 20% + Difenoconazole 12.5%), Tilt 250 EC (Propiconazole 25%), Folicur 250 EC (Tebuconazole 25%) and Trooper 75 WP (Tricyclazole 75%) were tested as new fungicides. The fungicides were sprayed twice, once at heading stage and another at 15 days of heading. An unsprayed control was maintained for comparison. The susceptible variety BARI Gom 26 was tested as a check one. Seeds were sown in 1.2 x 2.5 m plots with 20 cm row-spacing on mid December 2016. The experiment was laid out in RCB design with three replications. Recommended doses of fertilizers were used and three irrigations were applied during the crop cycle. Percent disease severity was scored as percent infected spike and percent diseased area on spike based on 0-100 scale. Data on grain yield per plot were recorded. Percent disease reduction and yield increase over unsprayed control were calculated and economic analysis also done.

Among the five fungicides tested against wheat blast, all were found effective in controlling the disease. Among them, Folicur 250 EC was found very effective in controlling wheat blast with least disease severity (0.8%) followed by Amistar Top 325 SC (1.1%) and Nativo 75 WG (1.3%), while the control plot displayed 14.6% disease severity. The unsprayed plot showed the highest disease severity. The percent disease reduction by the fungicides ranged from 82 to 95% over unsprayed plot. The highest grain yield was obtained with Nativo 75 WG, and the increase in yield by this fungicide over unsprayed control was 34%, which was followed by Tilt 250 EC and Folicur 250 EC, while the lowest with Amistar Top 325 SC. Similar trend on net profit also found on the treatments. Bioassay of MoT was also done against different foliar fungicides with full (recommended dose) and half dose. Results revealed that all of the fungicides showed hundred percent suppression of the fungus i.e. *P. ory*zae with recommended and half dose, while control treatment showed a good growth of the fungus. All the five selected fungicides viz. Nativo 75 WG, Amistar Top 325 SC, Tilt 250 EC, Folicur 250 EC and Trooper 75 WP were found effective in controlling wheat blast infection with significant increase in yield and economic benefit. Hundred percent suppression of the fungus also found in Bioassay method. Among them, Nativo 75 WG (Tebunaconazole 50% + Trifloxystrobin 25%) was found most effective due to the highest grain yield increase (34%) and net profit (Tk.28005/ha) as well as disease reduction 91% over controlled plot.

Investigation into alternative hosts and cereals of wheat blast pathogen

Wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Though seed transmission of the wheat fungus has been demonstrated, seed infection may play a limited role in epidemiology, where spikes are mainly infected by air-borne conidia from host grasses. Several grasses and weeds occur commonly in wheat fields and are secondary host, but their role in epidemiology of wheat blast is not well understood and even less so in Bangladesh, but there is no guarantee that the pathogen is not present in the alternate host. Therefore, it is inevitable to investigate into alternate host in order to identify the wheat blast pathogen.

Symptomatic and asymptomatic leaf samples were collected from winter cereals, weed species others grown in the fields of South-western and southern parts of Bangladesh. The samples were cut into 1-2 cm pieces, surface sterilized with chlorox and plated on wet blotters. After 2-4 days of incubation at room temperature the specimens were examined under stereomicroscope for fungal growth. The incidence of *M. oryzae* associated with leaf samples were calculated and expressed as percentage. The winter cereals namely wheat, Rice and foxtail millet, and the weed species such as Goose grass, Crab grass, Torpado grass and Basket grass showed presence of *Pyricularia* sp. associated with their leaves. Results indicated that there is possibility of existence of alternate hosts of *Pyricularia* sp. that may serve as sources of inocula for causing wheat blast in Bangladesh. However, the species of the fungi from different cereal and weed species were genetically distinct to *Pyricularia oryzae* pathotype *Triticum* by confirming PCR analysis. Therefore, it will be need to inoculate on the suspicious weed species by wheat isolate for more confirmation in the coming season. Among the alternate hosts, some of the cereals and weed species may serve as alternate hosts of Pyricularia sp, causing wheat blast in Bangladesh. However, the species of the fungi from different cereal and weed species were genetically distinct to Pyricularia oryzae pathotype Triticum by confirming PCR analysis. So, it is inevitable to inoculate on the suspicious weed species by wheat isolate for more confirmation in the coming season.

Determining status of seed-borne fungi including *Pyricularia oryzae* causing wheat blast

Infected or contaminated seeds serve as major source of inoculum for large number of plant pathogens which may infect the seeds and survive as spore or resting structures on or within the seeds. Wheat seed harbor several species of fungi, which can reduce seed quality and cause plant disease. Fungi carried on or within seeds reduce seed germination, seedling emergence and lead to less vigorous seedling. Seed-borne fungal pathogen present externally or internally may cause seed abortion, seed rot and seed necrosis. Some plant pathogenic fungi kill seedlings shortly after they emerge, whereas others cause serious disease epidemics after being transmitted from seeds to seedlings. Seed-borne diseases also affect the growth and productivity of wheat. Seed-borne fungi reported in wheat include *Bipolaris spp., Alternaria spp., Curvularia spp.* etc.. Unfortunately, Wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh and also a seed-borne disease. Although, in literature showed that seed play a minor role on the transmission of the pathogen. Thus understanding disease epidemiology, its transmission rate and economic threshold, combined with seed health testing in the study areas is very important, as these could help to define the need for seed treatment. The present investigation was therefore, undertaken to determine prevalent seed-borne fungal pathogens along with wheat blast pathogen present in research station trial sites seeds.

An effort was made to determine the incidence of *Pyricularia oryzae* and seedborne fungi associated with wheat seeds of six varieties collected from five different locations of Bangladesh. A total of 23 fungi were identified from seed samples of different locations. Among them *Bipolaris sorokiniana* and *Alternaria alternata* were most predominant. Results showed that *Pyricularia oryzae* incidence and seedborne prevalence of two predominant fungi *B. sorokiniana* and *A. alternata* varied among different locations, varieties and time of sowing. The overall *Pyricularia oryzae* incidence was estimated to 3.99 percent. The highest percentage of *Pyricularia oryzae* infected seeds was recorded in Jessore, which was followed by Rajshahi and the lowest in Jamalpur. The locations Dinajpur and Joydebpur seeds were completely free from *Pyricularia oryzae* infection in both conditions (ITS & ILS). The lowest incidence of *B. sorokiniana* (33.75%) was observed in BARI Gom 30 while the highest (44.5%) was recorded in BARI Gom 28, which was followed by BARI Gom 26 (43.4%). When location is considered, the minimum and maximum incidences of *B. sorokiniana* were observed in Jessore and Jamalpur, respectively. The overall mean seedborne incidence of this fungus was estimated to 40.29 percent. Incidence of *A. alternata* was found highest in Rajshahi and lowest in Jamalpur. In case of variety, the highest prevalence of this fungus was observed in BARI Gom 29 followed by Prodip and the lowest in Shatabdi.

Effect of sowing dates and genotypes on the severity of wheat blast caused by *Magnaporthe oryzae* pathotype *triticum* (MoT)

Wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* (anamorph *Pyricularia oryzae*) was first described infecting wheat (*Triticum aestivum* L.) spikes in the state of Paraná, Brazil, in 1985 and it spread to about 3 million ha with 10-100% yield losses; depending on the year, genotype, planting date, rainfall, and disease severity. Unfortunately, the disease emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. The areas affected cover about ~20% of Bangladesh's total wheat area in 2015-16, presenting a significant threat to the country's aggregate wheat production. However, the epidemiology and life cycle of the pathogen is still largely unknown. Therefore, it is important to determine the effect of sowing time on wheat blast infection in different wheat varieties at various growth stages. The objective of this work was to assess the effect of sowing date on the intensity of wheat blast disease in different wheat (*Triticum aestivum*) genotypes. The experiment was conducted in 2016-17 at RARS, Jessore. Six wheat genotypes and five sowing dates were evaluated. The experimental design was a randomized complete block with three replicates. The evaluated variables were: incidence, severity, thousand grain weight (TGW) and grain yield. Disease severity (DS) was calculated, based both on the incidence and the severity of the disease, to measure blast severity in wheat. The sowing date significantly affected DS, TGW, and grain yield. Wheat planted in optimum time had low or no disease incidence, but it increases with the later sowing dates. The highest disease severity was observed with variety BARI Gom 26, which ranged from 0-60%. Decreasing trend of yield reduction also observed with this variety. The lowest disease severity was found with variety BARI Gom 30, which about 0-18%. There was no yield reduction in this variety as compared to early sowing dates. BARI Gom 30 was comparatively more tolerant to blast, when exposed to high disease pressure.

Seed to plant transmission of wheat blast fungus

Seedborne infection of wheat by *Pyricularia oryzae* and its transmission seed to seedlings were studied quantitatively with naturally infected seeds. The blast susceptible variety BARI Gom 26 was used for the experiment. The seed infection percentage was determined by seed health testing 1 week prior to the start of the seed transmission studies. Initial incidence of *Pyricularia oryzae* on the tested seeds was recorded by moist blotter method, which was about 70-75%. Occurrence of other organisms on the seeds was also recorded. The treatments were arranged in a randomized block design with four replications. The treatments were followed: a) seeding in sterilized and non sterilized soil; b) seeding in water-agar media; and c) seeding in filter paper. Seeding in water agar and seeding in filter paper were done in laboratory conditions, while seeding in sterilized and non sterilized soil were done in natural condition. Seeds sowing or/ plating in all methods were done from 1st week of May to last week of May 2017. Plants with about 7-10 days aged were subjected to 24 hrs incubation by polyhood with providing humidity for seeding in water agar and seeding in soil methods. After 10-20 days of sowing or plating, germinated plants were taken out from water agar/filter paper/soil to examine under stereo-microscope for MoT transmission from seeds to seedlings with observation of two types of symptoms: death of seedling and symptoms on leaves with no death.

Transmission of *P. oryzae* from seeds to seedlings, studied under various seeding conditions, showed that the transmission rate was low to high depending on seeding methods. The highest frequency (86%) of *P. oryzae* transmission was observed on seeding in Water Agar media. Lower infection frequency was observed in seedlings raised in sterilized soil than in seedlings raised in unsterilized soil. Thus, the highest death seedlings were occurred in seeding in non-sterilized soil which was about 58% and lowest (3%) in seeding in filter paper. Symptoms on the leaves also higher in non-sterilized soil than the other methods. Growth of the fungus was found on coleoptiles that had visible necrotic symptoms. Mostly, the fungus found on the coleoptiles, sometimes on the primary roots and only a few on the first leaf showed typical water soaked lesion. That means the fungus may have the chance seed to plant transmission.

Response of temperature and wetting period on wheat blast infection

Occurrence of wheat blast caused by *Magnaporthe* oryzae (syn. *Pyricularia oryzae)* pathotype *Triticum* (MoT) was first spotted in Bangladesh in 2016. Farmers get no time to take necessary measure to combat the disease when it has already appeared. An improved understanding of the effect of temperature and wetting period for MoT development in relation to wheat phonology under field condition is, therefore, needed as an essential input to develop a forecasting system.

The experiment was conducted under field conditions in two locations- Dinajpur and Jessore. Six sowing dates, viz., 10 Nov., 20 Nov., 30 Nov., 10 Dec., 20 Dec., and 30 Dec. were taken as main plot, five wetting periods i.e., 0, 6, 12, 18 and 24 hrs as sub-plot. The blast susceptible variety BARI Gom 26 was used for this experiment. The materials were planted in 5m long 6 row-plots with 20 cm spacing between rows to row. The nursery was surrounded by spreader rows composed of mixture of susceptible varieties. Recommended fertilizers and cultural practices were followed for normal crop growth. Wettings were done at heading stage by a misting device set in the experimental plot. Misting were done at 5 Jan., 19 Jan., 31 Jan., 13 Feb., 22 Feb. and 2 Mar. for the sowing dates 10 Nov., 20 Nov., 30 Nov., 10 Dec., 20 Dec., and 30 Dec., respectively. After misting, the individual plots covered by plastic hood for specified periods to maintained desired wetness duration. Temperature and humidity data were recorded by automated weather station equipped with a data logger. Wheat blast severity was recorded in Jessore as percentage of spike infected and percentage of disease area on spike and converted to disease severity. Agronomic data were recorded on days to heading, plant height, 1000-grain weight and grain yield. The highest blast intensity was observed at 23-24°C with sowing dates 30 December and wetting periods 24 hrs, while the lowest occurred at 17-19°C with sowing date 10 November and no spike wetness. Mean relative humidity was prevailed about 77-79 % during the wheat growing season at study site. Seed sowing at 10 November and 20 November have not significant variation on disease severity among the treatments. Although, sowing at 10 Dec., 20 Dec. and 30 Dec. have significant variation with no wetting period to wetting periods only, but not among the different wetting hours.

Farm Mechanization

Design and development of a 4-wheel tractor operated seeder for cereal crops

Rice-Wheat is the main cropping system in our country. Currently, Bangladesh produces 34.5 million metric tons (4^{th} largest) of rice , 23 lac m. ton of maize and 13.5 lac metric tons of wheat every year.

Wheat is the second most important food grain after rice. The area under maize and wheat system is increasing every year. Most of the cereals, pulses and other crops have traditionally been planted through 3-4 ploughing followed by laddering which is slow, laborious, time consuming and costly. Timely planting and timely harvesting is the key operations for increasing cropping intensity and achieving the desired yield. The optimum wheat planting period is 1st November to 30th November. Wheat planting after this period cause yield decrease at the rate of 45 kg/ha/day. PTOS (power tiller operated seeder) first initiated a good opening but it can't always fulfill the requirement against timely sowing due to weather or time constrains. Now we think about a better and a bigger alternative. The tractor driven seeder can be used as a target achiever. It is two and a half times faster and bigger than PTOS. The tractor driven seeder also provides operators' comfort and safety operation. It also saves fuel and time as well as environment friendly. The main objectives of the experiment are i) design and development of a 4 wheel tractor operated seeder for cereal crops, ii) to set up seeding device on rotavator with 4w tractor for multi crop seeding ii) to test and evaluate the percent emergence of seed for the tractor driven seeder and iv) to compare the performance of tractor operated seeder with power tiller operated seeder

A 4-wheel tractor operated seeder was designed and developed for direct seeding of cereal and other seeds, such as Rice, Wheat, Soybean, Mugbean, Mustard, Dhaincha etc. For this, an eight teeth, 4.5 cm outer diameter fluted type seed metering device was used. The seeder was fabricated with locally available iron materials in the workshop of Wheat Research Centre, BARI, Nashipur, Dinajpur during 2016-2017. It was connected with the roller through chain and sprocket system. When the tractor moves forward, rotavator tills the land, the roller rotates and the power is transmitted from the roller via the chain and sprocket to the seed meter and thus the machine operates. When the rotavator is dismantled from the assembly, the 4 wheels tractor operated seeder also may be used as a zero tillage cultivator. Thus it can act as a conservation agricultural machinery. The experiment will be continued to the next year for field trials and better performance.

Technology validation and transfer

Demonstration of newly released wheat varieties

Wheat is the second most important cereal crop after rice in Bangladesh and its consumption is increasing by 10% per year. The tragic irony is that the wheat production in the country 1.4 million tons, which is much bellow than the annual requirement. Wheat is to compete with other profitable crops like Boro rice, corn, potato and winter vegetables which insisting farmers to push wheat crop in marginal lands from fertile ones and this is considered as the main reason for decreasing area under wheat. Yield was also decreasing due to cultivation of old varieties that are susceptible to leaf rust and BpLB, knowledge gap about recommended technologies.

For increasing wheat production in Bangladesh, it is very important to adopt new technologies recommended by Wheat Research Centre. Use of power tiller operated seeder (PTOS) to confirm timely seeding and use of wheat thresher is also important to save the quality of seeds from early monsoon. WRC of Bangladesh Agricultural Research Institute (BARI) has released 32 varieties in conventional breeding approach and most of the later released varieties are better than previous one in respect of yield, disease and terminal heat tolerance. But those varieties and other technologies are not being adopted by the farmers in a satisfactory rate due to their inadequate knowledge about the varieties and technologies and insufficient extension efforts.

Technology transfer programmes were undertaken by Wheat Research Centre during 2016-17 to enhance technology adoption, get feedback from farmers and extension officials and increase wheat yields reducing yield gap by minimizing farmers' knowledge gap. Technologies were transferred through demonstrations, seed dissemination, trainings, field days, visits, publications, etc. Seven hundred eighty seven demonstrations were conducted with 6 newly released wheat varieties viz., BARI Gom 25 & BARI Gom 26 (released in 2010), BARI Gom 27 & BARI Gom 28 (released in

2012) and BARI Gom 29 & BARI Gom 30 (released in 2014) in the farmers' fields of thirty-two districts out of sixty four under 11 agricultural regions in 2016-17. The mean yield of all the six varieties over locations was 3.73 t ha^{-1}. The highest mean yield was recorded in BARI Gom 30 (4.03 t ha^{-1}) followed by BARI Gom 26 (3.79 t ha^{-1}), BARI Gom 29 (3.71 t ha^{-1}), BARI Gom 28 (3.68 t ha^{-1}) and BARI Gom 25 (3.67 t ha^{-1}). There were no significant differences among these 4 varieties. BARI Gom 27 had the lowest yield (3.46 t ha^{-1}). Considering region, The highest yield was obtained from Rajshahi region (4.13 t ha^{-1}) followed by Khulna region (4.11 t ha^{-1}) and Faridpur regions (4.03 t ha^{-1}). The yields at Dhaka and Sylhet regions were the lowest (3.19 and 3.18 t ha^{-1}, respectively). The mean yield of wheat under farmers' management was 3.22 t ha^{-1} and overall mean yield of the new six varieties was 3.73 t ha^{-1}. The difference between these two yields (yield gap) was 15.84%. So, the yield gap between variety demonstrations in farmers' field and neighbouring farmers' fields yield can remarkably be eliminated using good seeds of good varieties, seeding in optimum time and using recommended fertilizers, irrigations and other management practices. About 31.5 tons of seed preserved by demonstration farmers and 29445 farmers of the same and neighbouring villages visited the demonstrations.

Yield maximization demonstration

Seed is the most important input but, it needs long time to reach the farmers through public channel. When the seeds reach to the farmers, many varieties start degenerate; as a result, the farmers could not harvest the full benefit of the new varieties. Therefore, participatory scaling up seed dissemination of new varieties is very important for rapid spread of a variety, as well as, increase varietal diversity. The main objective of yield maximization demonstration is to show the superiority of new varieties and recommended technologies.

BARI Gom 28, BARI Gom 29 and BARI Gom 30 were demonstrated in 1.0 acre block (each variety in 33 decimal plots) at farmer's field of Thakurgaon, Rajshahi, Tangail, Jessore and Jamalpur. Recommended dose of fertilizers and seeds were supplied to each farmer of those villages for establishing the demonstration with the condition of preserving and selling the product as seeds. The scientists of WRC helped them update their knowledge regarding good seeds, good varieties, optimum seeding time, optimum doses of fertilizers, irrigations and other management practices through training and field visits to maximize the yield of the new varieties of wheat. Seeding of the demonstration plots was done during 20 November to 03 December 2015. The data on yield of demonstration plots and seed preservation were taken. The yield of wheat that was received by farmers with their own management practices was also taken to quantify the yield gap between the WRC recommended practices with the farmers' practices.

The highest mean yield over locations was recorded in BARI Gom 30 (4.22 t ha^{-1}) followed by BARI Gom 28 (4.12 t ha^{-1}). The mean yield of wheat in neighbouring farmers' fields under farmers' own input and management was 3.05 t ha^{-1} and the overall mean yield of the new three varieties was 4.12 t ha^{-1}. The difference between these two yields (yield gap) was 27.16% (nearly one ton per hectare). So, the result indicated that yield gap between block demonstration in farmers' field and neighbouring farmers' fields yield can remarkably be eliminated using good seeds of good varieties, seeding in optimum time and using recommended fertilizers, irrigations and other management practices. Actually the yield gap is mainly due to management gap (knowledge gap of the farmers about proper crop management) and also gap due to improved latest wheat variety.

Training

Farmers, Government and NGO personnel were trained to make them familiar with the new wheat varieties, modern crop management practices, seed preservation techniques and mechanization in wheat cultivation. Training programme for farmers, extension officers, young scientists, WRC field staffs, NGO personnel and others were conducted through audio-visual aids, demonstrations, lectures, group discussions, training classes, field days, motivational tours etc. by wheat scientists.

A total of 1589 personnel from different organizations attended training programmes of Wheat Research Centre given in different aspects during 2016-17. Out of those, 1292 farmers and local service providers (LSPs), 132 SAAO/SSA/SA and NGO's field staffs and 20 Officers of WRC were trained on wheat. In demonstration training, about 90 extension officials were also participated as observer. Trainings were imparted on new wheat variety demonstration, dual-purpose triticale variety demonstration, wheat seed production and preservation technologies, PTOS and multicrop reaper etc.

Workshops

Wheat Research Centre, BARI, organized nine workshops at different locations of the country during 2016-17. Among these, seven workshops were conducted on management of wheat blast and keys to improve wheat yield in different agricultural regions of Bangladesh where scientists from different research organizations, officials (UAO, ADD, DTO, DD and AD) from Department of Agricultural Extension, Bangladesh Agricultural Development Corporation, and Seed Certification Agency and teachers from public universities were present. A travelling workshop was also conducted to mitigate the thread of wheat blast in Bangladesh. At the beginning of workshop, the wheat scientists were trained on disease surveillance and development of monitoring skill. After that, three working groups were formed for surveillance and collection of both symptomatic and asymptomatic blast sample from blast affected areas of Jessore, Barisal and Rajshahi regions. Samples were also collected from blast non-affected areas of Rangpur and Dinajpur regions. The draft report of research findings and proposed research programmes for coming season were presented and discussed in the pre-review workshop at WRC, Dinajpur with the participation of wheat scientists from different stations of BARI.

Field days, visits and publications

A group of scientists and DAE personnel visited the demonstrations and seed production plots several times and were impressed to see the plots. A good number of visitors both from home and abroad also visited the on-station and on-farm activities of WRC. Students from different college and universities, WRC technologies were presented to them during their visit. Thirteen field days were organized by WRC, Dinajpur in seed production and new variety demonstration plots where about 1320 farmers and 51 DAE & related personnel and five local people representatives were present. The participating farmers in the field days were very much interested to cultivate new varieties of wheat. Huge number of coloured pictorial factsheets and folders of wheat blast and how to mitigate the disease, both in Bangla and English, were published and distributed among the farmers and related personnel.

Rajshahi, Khulna and Faridpur regions had higher yields than other regions. Though, there were some variations in yields among the genotypes, the farmers preserved seeds of all new varieties for next year. This will increase wheat yield and varietal diversity which are also important from the view point of disease epidemic. Yield maximization demonstration in large plots in farmers' fields proved that near about 1.07 t ha^{-1} yield can be increased in farmers' field by using good seeds of new varieties, recommended fertilizers use with irrigation, etc. Good quantity seeds of six new varieties were made available to the farmers through different technology transfer activities. This will help rapid dissemination of new wheat varieties.

Maize

Variety improvement

The main objective of the Plant Breeding Division, BARI is to develop high yielding maize varieties as well as minor cereal crops varieties (barley, millets and sorghum) with a view to enhance maize and minor cereal crops productivity in Bangladesh. Development of climate resilient maize variety has been given the highest research priority under the content of global climate change. Emphasis has also been given to develop nutrition enrich maize varieties. Molecular research is going on to identify abiotic as well as multi stress tolerance mechanism. The performance of newly developed maize hybrids from national and international sources specially CIMMYT are being evaluated under different growing environments across the country and promising hybrids superior to the standard check varieties are selected. In addition, research thrust has been put forward towards developing new hybrids, inbred development and seed production.

Development of drought and salt tolerant barley (hulled and hull-less) as well as millets are also emphasized. Priority has also been given to disseminate and popularize developed technologies among farmers and private agencies through block demonstration, farmers training, workshop, field days, publications etc.

A. Collection, characterization and maintenance of germplasm

Maintenance and seed increase of promising inbred lines of maize

Inbred lines represent a fundamental resource for producing maize hybrids. The quality of hybrid seed greatly depends on field production methods, both in adherence to quality assurance standards and implementation of appropriate agronomic management. Inbred lines are the result of repeated self-pollination of particular maize populations to produce a plant that essentially has a fixed and uniform genetic composition.

One hundred sixty five exotic inbred lines of field corn from the International Maize and Wheat Improvement center (CIMMYT) were maintained through selfing carefully by hand pollination. Total 1188 number of selfed ears were harvested from different inbred lines and preserved separately for future breeding programme.

B. Development of source population and inbred lines

Development of base population in maize (2 sets)

The source population development is very important for the development of elite inbred lines. Elite inbred lines are important for the development of superior hybrids in maize. For making our own source of germplasm, a mixture of 39 top yielding commercial maize hybrids of 6th cycle were planted in two sets (two groups) in isolation condition. Each of the groups contained 100 selected selfed ears which were selected in previous year. The desirable selfed bulk seeds from each set were selected based on two groups, viz. (i) medium height and high yield goal and (ii) dwarf, earliness and medium yield goal. For next cycle of selection and inbred development from desirable plants, finally 100 selfed ears were selected separately from each of the two groups based on the specific objective and preserved them carefully for next year selection .

Recycling for development of maize inbred lines (1 set)

Extraction of superior inbred lines through recycling is a common technique in maize breeding. Seeds of commercial hybrid IM8119 field corn were grown to advance from S_0 to S_1 generation. The selected plants were selfed by hand pollination carefully. Finally 120 selfed ears of S_1 were selected, dried properly and kept separately in store for advancing S_2 lines in the next rabi season.

Advancing S_1 to S_7 generation of field corn, popcorn, baby corn and sweet corn (24 sets)

Inbred line development from commercial hybrids following selfing is an common technique in maize breeding. The balanced bulk selfed seeds of S_1 sweet corn (20 S_1 lines of Dream sweet, and 12 S_1 lines of Dream sweet 3) were advanced to S_2 generation. Among them 78 and 22 selfed ears were selected from Dream sweet and Dream sweet 3, respectively & preserved separately for advancing them to next generation and used them for testcross hybrid production.

The balanced bulk seeds of S_2 baby corn (Baby star, 20 lines) and field corn (IM 8013, 30 lines) were advanced to S_3 generation. Variations were found among the S_2 lines for different traits. The selected S_2 plants in each line of each set were selfed and finally 115 and 87 selfed S_3 ears of Baby star and IM 8013 were preserved for advancing them to S_4 generation and development of test cross hybrid.

Nine sets of S_3 lines (Set I: Early and dwarf line, Set II: Medium height and high yield, Set III: Swiss pop corn, Set IV: Titan, Set V: 9120, Set VI: Multi parent synthetic line-Ishurdi, Set VII: Multi parent synthetic line-Barisal, Set VIII: Multi parent synthetic line- Gazipur) were advanced to S_4 generation following ear to row method. Variations were found among the lines for different traits. The selected S_4 selfed ears were stored separately for advancing them to S_5 generation following ear to row method in the next rabi season.

Three sets of field corn hybrids viz. Arun (15 lines), 981(25 lines) and Pinnacle (30 lines) and one set of popcorn variety viz. Popcorn Nepal (21 lines) were advanced to S_5 generation in order to develop superior inbred line(s) following ear to row method. Variation was found among the S_4 lines of each set for different traits studied. Selected S_4 plants were selfed and S_5 seeds were collected for advancing them to S_6 generation.

The S_5 lines of two field corn hybrids 981 (30 lines) and Pioneer (40 lines) were advanced to S_6 generation following ear to row method. The plants were seemed to be mostly uniform in height. Selected S_5 plants were selfed and finally 184 and 175 ears for 981 and Pioneer were preserved for next generation advancing.

Three sets of S_6 lines of field corn varieties viz. 7074, 981 and Local Germplasm (LG) and two sets of popcorn varieties PCB10 and Thai pop corn were advanced to S_7 generation in order to develop superior inbred lines following ear to row method. This is the final stage of inbred development through recycling. There was no variation among the lines in plant height and those were supposed to attain uniformity and homozygosity. These fully developed inbred lines would be used in hybrid development.

C. Evaluation of inbred lines

Genetic diversity in new maize inbred lines

To assess the divergence among 47 genotypes in maize, Mahalanobis D^2 statistics was applied based on 10 yield and yield contributing traits. The genotypes were grouped into 5 clusters, where cluster I was the largest containing 16 genotypes followed by cluster IV with 11 genotypes, cluster V with 9 genotype and cluster II and III with 7 and 4 genotype, respectively. The maximum inter cluster distance was observed between cluster II and cluster III (D^2=8.05); and cluster II and cluster IV (D^2=8.05) indicating wider genetic diversity among genotypes in these groups and lowest between cluster I and cluster V (D^2=3.94). While, Intra cluster D^2 value was maximum in cluster II (0.46). Cluster I exhibited highest mean values for most of the traits. The crosses involving parents/inbred lines from most divergent clusters were selected which could be intercrossed to obtain high heterotic expression.

Evaluation of inbred lines of field corn through line × tester method (6 sets)

In set I, twenty selected inbred lines of field corn were crossed with 2 testers (CML161 and CML 165) as male parent in a Line × Tester mating design and the resulting 40 crosses along with the parents and three checks (BHM9, 981 and BHM5) were evaluated in a alpha lattice design with two replications at Gazipur. Among the lines VL109279 and CLQRCYQ74 and tester CML165 were good general combiners for grain yield and some of the important yield contributing characters. Line VL109579 and CML171 were good general combiners for earliness and short stature, respectively. CML 165 was good combiner for yield. Three crosses viz. CML 163 × CML 161, CML 171 × CML 161 and CML 193 × CML 165 showed high SCA effects with high standard heterosis (16.7-27.5%) & high mean performances (11.2-12.7 t/ha) for yield which could be used for commercial hybrid development after verification.

In set II, another twenty selected different lines of field corn were crossed with 2 testers (CL02450 and CML 451) in a Line × Tester mating design to generate 40 crosses. All the crosses along with the parents and standard checks (BHM9, 981 and Sunshine) were evaluated in a alpha lattice design with two replications at Gazipur. The parents CML 430, CML 429, CML 223 and CML 451(tester) could be used in hybridization programme as donor. Better performing two crosses (CML 287 × CML 451 and CML 431 × CLO2450) showed high heterosis over standard check and also had high mean yield (10.4-11.4 t/ha) were selected to evaluate in multilocation trial.

In set III, 30 selected of Pinacle S_3 lines of field corn were crossed with two different testers (BIL 28 and BIL79) in two isolations to generate test crosses (rabi 2015-16). The test crosses and their parents were evaluated along with three cheeks (BHM9, 981 and Sunshine) in a alpha lattice design with two replications at Regional Agricultural Research Station, Jessore, to test combining ability and heterosis for particular traits of economic importance in rabi 2016-17. The best GCA was observed for PNL/S_3-4. Seven crosses (PNL/S_3-4, PNL/S_3-7, PNL/S_3-12, PNL/S_3-14, PNL/S_3-15 crossed with BIL-28; PNL/S_3-4 and PNL/S_3-24 crossed with BIL-79) showed higher kernel yield ranged from 9.74-12.18 t/ha.

In set IV, 30 S_3 selected lines of field corn were crossed with two different testers (BIL28 and BIL79) in two isolations to generate test crosses in rabi 2015-16. The test crosses and their parents were evaluated with three cheeks BHM9, 981 and Sunshine in a alpha lattice design with two replications at Regional Agricultural Research Station, Jessore, to test combining ability and heterosis for particular traits of economic importance in rabi 2016-17. The best GCA was observed for 981/S_3-24. Kernel yield ranged from 7.22 to 13.87 t ha^{-1}. Maximum yield was for 981/S_3-12 (13.87 ton/ha), using BIL-28 as a tester. A total of 22 test crosses showed kernel yield higher than mean of checks (11.03 ton/ha).

The experiment was conducted with 17 inbred lines of field corn crossed with 4 testers (Set V) in a Line × Tester mating design and the resulting 68 crosses with the parents were evaluated along with three cheeks (BHM9, 981 and Sunshine) in a alpha lattice design with two replications at Gazipur. The inbred parents 7074/S_6-15, B-3, A-6, F-7-1 and F-10 were found as the good general combiner for yield. Two crosses 7074/S_6-15×BIL 28 and 7074/S_6-5×BIL 28 showed high mean yield (11.47-11.56 t/ha), significant positive sca and significant higher positive standard heterosis (10.2% and 9.3%) were identified as the best combinations.

In set VI, 41inbred lines of field corn were crossed with 2 testers (BIL 110 and BIL157) in a Line × Tester method and the resulting 82 crosses along with the parents and three standard checks (BHM9, 981 and Sunshine) were evaluated in a alpha lattice design with two replications at Gazipur. Eight lines viz. A-21-2,A-3, F-2, F-4, F-13, F-19, F-21-2 and F-31-1 were found good general combiner for grain yield. Better performing 3 crosses A-21-2×BIL 110, 7074/S_6-6×BIL 110 and F-2×BIL 157 showed significant positive SCA, significant positive heterosis (8.5%-16.9%) for yield and also high mean yield (11.38-12.27 t/ha) were selected as the best combinations. These crosses could be utilized for commercial hybrid after verification under wider agro ecological zones of Bangladesh.

Combining ability and heterosis in field corn (2 sets)

In set I, seven inbred lines of field corn were crossed in all possible combinations (excluding reciprocals) and the resulting 21 F_1's along with 3 commercial hybrids viz. BHM9, Sunshine and 981 were evaluated following alpha lattice design with 3 replications at Gazipur. Parents P_4 and P_7 were the best general combiner for high yield; P_1 and P_2 for dwarf & earliness. Two crosses ($P_3 \times P_7$ and $P_4 \times P_7$) showed high mean yield (9.61-11.08 t/ha). These two crosses also showed significant positive sca and positive standard heterosis for yield. The hybrids need to be further evaluated for confirmation.

In set II, 8 diverse inbred lines of field corn were crossed in all possible combinations (excluding reciprocals) and the resulting 28 F_1's along with 2 commercial hybrids viz. BHM7 and 981 were evaluated in a alpha lattice design with two replications at Gazipur. Parent P_4 and P_6 was the best general combiner for high grain yield and parent P_7 and P_8 for earliness and dwarf plant type. The highest heterosis was exhibited by the cross $P_2 \times P_4$ (10.83%) followed by $P_6 \times P_7$ (9.72%). Three crosses $P_2 \times P_4$, $P_6 \times P_7$ and $P_4 \times P_6$ showed high mean yield(11.82-13.02 t/ha) as well as higher heterosis and sca effects can be utilized for developing high yielding hybrids as well as for exploiting hybrid vigour.

D. Evaluation of single cross and three way cross hybrids

Evaluation of early, short stature and high yielding single cross field corn hybrids

Twenty single cross of field corn hybrids were evaluated along with four commercial checks BHM 9, 981, Pioneer 3396 and Sunshine in RCBD with two replications at Gazipur. Significant differences were observed among the genotypes for all the characters studied. Two hybrids BMZ 25 × Ki 21 and BMZ 68 × CML 487 showed high mean yield (10.05-10.72 t/ha) with low plant height. These hybrids were found promising and selected for further evaluation at different locations.

Evaluation of promising field corn and baby corn hybrids in different agro-ecological regions of Bangladesh (5 sets)

In set I, eleven promising crosses of field corn and four checks (BHM9, 981, Sunshine and BHM5) were evaluated at five locations viz. Gazipur, Hathazari, Rahmatpur, Burirhat, and Jessore in RCBD with three replications. The AMMI (additive main effects and multiplicative interaction) model was used to analyze the genotype-environment interaction over five locations. Considering yield potentiality and stability parameter hybrids, E1 (11.87 t/ha) and E2 (11.11 t/ha) showed higher yield as well as stable across locations and were selected for further verification.

In set II, 13 single crosses and two checks (BHM9 and 981) were evaluated in RCBD with 3 replications at five locations namely Gazipur, Ishurdi, Rahmatpur, Jessore and Rangpur to assess genotype-environment interaction (GEI) and stability for selection of the best hybrid. Gazipur, Ishurdi and Jamalpur were poor and Rangpur and Barisal were good environments for maize production. Among all the hybrids, A-9×B-19 showed the highest yield (12.04 t/ha) and was found stable across the locations.

In set III, seven baby corn hybrids were evaluated at six environment viz. Barisal, Gazipur, Hathazari, Jamalpur, Jessor and Rangpur along with two commercial check varieties namely Baby Star and MSC 001. The AMMI (additive main effects and multiplicative interaction) model was used to analyze the genotype-environment interaction over six locations. Barisal was the most suitable and Hathazari was the poorest environment for baby corn cultivation. Among the hybrids, BCP 271-18×BCP 271-6 and BCP 271-18×BCP 271-16 had higher number of cobs per plant and hybrids BCP 271-13×BCP 271-7 (637 g) and BCP 271-20×BCP 271-19 (657 g) had high green fodder per plant and were found stable over the environments.

In set IV, Thirteen maize hybrids along with five check varieties (BHM 9, 981, Sunshine, Pioneer and Kaveri 60) were evaluated for genotype environment interaction (GEI) and stability for the selection of promising one(s) in six different locations namely Gazipur, Jamalpur, Hathazari, Rahmatpur, Burirhat, and Jessore in RCBD with 2 replications. The AMMI (additive main effects and multiplicative interaction) model was used to analyze the genotype-environment interaction over six locations to select the hybrid having higher yield and other potential attributes. Among the hybrids, 9MS/S7-9×BIL-114 was high yielder (11.12 t/ha) and was stable across the locations.

In set V, twenty five hybrids including 4 checks (BHM9, Pioneer3396, Sunshin and 981) were evaluated in Alpha lattice design with 3 replications at five locations namely Gazipur, Rangpur, Jamalpur, Barisal and Jessore to assess genotype-environment interaction (GEI) and stability for selection of the best hybrid. Rangpur, Jamalpur and Gazipur was poor but Barisal and Jessore were rich for hybrid maize production. Among the tested hybrids, E16 (10.7 t/ha) and E21 (10.79 t/ha) were high yielder and stable across five environments.

Evaluation of short stature maize hybrids in different locations

Seventeen promising field corn hybrids along with three commercial check varieties (BHM 9, 981 and Sunshine) were evaluated at five different locations namely Gazipur, Rangpur, Jamalpur, Barisal and Jessore in RCBD with 3 replications. The AMMI model (additive main effects and multiplicative interaction) and GGE Biplot were used to analyze the genotype-environment interactions over five locations to select the hybrids having higher yield and other potential attributes. Rangpur was found highly suitable for hybrid maize cultivation followed by Jamalpur. F-14×M-14, F-30×M-10 and $P_3 \times P_7$ were stable but low yielding. Among the hybrids, F-30×M-15(11.75 t/ha) , F-14 ×M-2(10.67 t/ha) and F-14×M-4 (10.54 t/ha) exhibited high yield as well as stable across environments.

E. Maize Biotechnology: Molecular breeding

Role of trehalose in maize under salinity and P stress

In this study, the level of oxidative stress and the participation of antioxidant and glyoxalase systems were investigated in seedlings of two maize genotypes BARI Hybrid Maize-7 (BHM-7) and BARI Hybrid Maize-9 (BHM-9) subjected to salinity and low P stress and addition of trehalose (Tre) was done to unveil the oxidative stress tolerant role Tre under salinity and low P. Addition Seven days old seedlings were imposed to 12 dSm^{-1} salinity and low P (10 ppm) for 5 days. Growth parameter as well as reactive oxygen species (ROS), lipid peroxidation (as melondialdehyde, MDA), methylglyoxal (MG), lipoxigenase (LOX) and enzymatic antioxidant and glyoxalase activities were investigated in fully expanded leaves. Salinity reduced the shoot length, root length and root volume in both genotypes. However, low P increased the root length and volume in both genotypes. In case of salinity plus low P stress, remarkable inhibiton was observed for these parameters in both genotypes. Addition of 100µM Tre in growing media increased all of the growth parameters. Salinity and low P increased all of the ROS, MDA, LOX activity and MG enormously in both genotypes. Application of Tre in the growing media lessened the oxidative damage in both genotypes by reducing the components. Under salinity, Increased SOD and POD activities were observed in both genotypes. Addition of trehalose did not increase the activity. Like salinity, low P stress also increased SOD activity in both genotypes, but addition of Tre further increased the activity over low P stress. The treatment Salinity+low P also reduced the SOD activity by 29% and 28% in BMH-7 and BMH-9, respectively. Notably, addition of Tre in this stress treatment maintained higher SOD activity in both genotypes. However, CAT is seemed not to important H_2O_2 scavenger. Increased activities of GPX and APX suggested being important scavenger in maize. Tre treatment further increased the activity in both genotypes. Like salinity, low P also increased the activity in both genotypes. However, in case of double stress, the activity drastically decreased. Addition of Tre restored the activity higher in both genotypes. Increased GR and DHAR activity under salinity signified their role in maintain GSH and ASA in maize. However, MDHAR activity decreased under salinity suggesting its interaction with ROS. The treatment Low P and double stress decreased the activities of GR, MDHAR and DHAR. Application of Tre increased the activities in both genotypes suggesting its restoring role of GSH and ASA in maize. Gly-I activity varied with genotype. In BHM-7, the activity decreased under stress and addition of Tre increased the activity. On the other hand, in BHM-9, salinity increased the activity, but low P decreased the activity. Tre supplement increased Gly-I activity indicated its importance in MG detoxification. On the other hand, higher activity of GST under the stresses with or without Tre in both genotypes could play detoxification and leaf senescence role in maize under stress.

F. Stress Breeding: Abiotic stress tolerant variety development

Screening of drought tolerant maize inbred lines at seedling stage under pot planting condition

An experiment was carried out with 29 CIMMYT maize genotypes in the green house of plant breeding division planted in pot (7″×3″). Pots were arranged using randomized complete block design with two replicates. Three seeds were sown in each pot and later thinned to one per pot. Each replicate was under two different treatments, treatment 1 (T1= Non stress / control; water was applied as and when required) and treatment 2 (T2= Drought stress / water stress; throughout the growing period). Pots were evaluated to identify best genotype(s) with very good performance at low moisture condition. Results were analyzed by using balanced two factor factorial analysis of variance, principal component analysis and biplot analysis for selection of tolerant genotypes. Highly significant differences among accessions for all the characters were found under water stress condition. First two principal factors showed more than one Eigen value under water stress condition. First two factors contributed 73.92% and 83.05% cumulative variability in stress condition. Leaf number, shoot fresh weight, shoot dry weight, plant fresh weight and plant dry weight were proved the most effective selection indicators against drought stress at early growth stage. Genotype E2, E11, E14, E18, E19 and E23 were better performer under drought stress.

Evaluation of maize hybrids in optimal and saline condition

Eight selected inbred lines were crossed in all possible combinations (excluding reciprocals) and resulting 28 F_1's along with 2 commercial hybrids viz. BHM9 and 981 were evaluated in RCB design with two replications in two different environments viz. Gazipur and Benarpota, Satkhira. Among the parents, P_1, P_3 and P_5 were good combiner for earliness, whereas P_2 and P_3 were shorter ear height. For hybrid, earliness was found in the crosses $P_1\times P_3$ & $P_1\times P_5$; and the crosses $P_2\times P_5$. $P_1\times P_3$, $P_2\times P_3$, $P_2\times P_6$, $P_3\times P_5$, $P_6\times P_7$ and $P_6\times P_8$ produced short statured plants. Considering earliness, plant height, ear height and yield $P_2\times P_3$, $P_2\times P_5$ and $P_6\times P_8$ were selected for further trial in multilocations.

Evaluation of single cross maize hybrids under saline condition

Forty two single cross hybrids of field corn along with six checks (BHM-9, 981, Sunshine, Pioneer3396, Kaberi 50 and Pacific 999 Super) were evaluated in RCB design with three replications at Benerpota, Satkhira under saline condition. None of the hybrid produced higher yield compared to the best check Kaberi 50. Considering earliness, plant height, ear height and yield hybrids $L_1\times T_2$, $L_3\times T_1$, $L_3\times T_2$, L5×T3, $L_6\times T_3$, $L_{10}\times T_1$ and $L_{11}\times T_3$ were selected to evaluate in the next year.

Evaluation of selected promising maize hybrids for saline areas (2 sets)

In set I, ten previously screened single cross field corn hybrids along with four commercial checks Sunshine, 981, BARI hybrid maize BHM 9 and BHM 12 were evaluated at ARS, Benarpota, Satkhira during rabi 2016-17 following alpha lattice with three replications. Considering high yield, percent heterosis and overall performance four hybrids; B-18× BIL-113, $P_7\times Q_2$, A-12-1×M-16 and BHM 12 (BARI released hybrid variety used as check) were found promising for grain yield, yield components and selected for further evaluation at different saline prone locations.

In set II, 14 hybrids including 2 checks (BHM-9 & 981) were evaluated in three saline areas viz. Satkhira, Khulna and Coxbazar in RCB design with 3 replications. The AMMI model (additive main effects and multiplicative interaction) was used to analyze the genotype-environment interactions over three locations to select the hybrid having higher yield and other potential attributes. Cox's bazar was found rich for hybrid maize production under saline condition whereas Satkhira was poor. Hybrids E5 (6.77 t/ha) & E11(6.44 t/ha) were high yielder but unstable. Hybrid E14 (6.40 t/ha) was high yielder and also stable across three environments.

Phenotyping of the HTMA hybrids under optimal temperature at Gazipur (10 sets)

The experiment composed of 10 sets of trials and a total of 345 maize hybrids from CIMMYT, India including six check varieties viz., BHM 9, 981, 942, NK 40, Pioneer 30V92 and Kaveri-50 were studied under HTMA project at the BARI Gazipur during the Kharif I season, 2016 to observe the performance of the hybrids under optimal temperature. Among the tested hybrids considering grain yield and other contributing characters the following hybrids, viz VH131167 (8.64 t/ha), ZH15445 (8.08 t/ha), ZH15419 (7.50 t/ha) and ZH141592 (7.08 t/ha) in trial AHSIII-19; entry ZH1610 (7.15 t/ha) in trial AHSIII-29; entries VH131167 (9.10 t/ha), ZH137177 (7.99 t/ha) and ZH137413 (7.46 t/ha) in trial ASHII-19 ; entries ZH15432 (7.62 t/ha) and ZH138069 (7.14 t/ha) in trial ASHII-29; entries ZH16835 (7.98 t/ha) and ZH15266 (6.80 t/ha) in trial DEIIYW-25; ZH138088 (9.07 t/ha), VH112881 (8.82 t/ha), ZH138088 (8.36 t/ha), ZH138077 (7.56 t/ha) and VH112881 (7.09 t/ha) in trial TWH-15 were selected for further evaluation in wide agro-ecologies.

Phenotyping of the HTMA hybrids under optimal temperature at Barisal (5 Sets)

A total of 160 maize hybrids from CIMMYT, India were evaluated under HTMA project including six check varieties viz., 981, 942, NK 40, Pioneer 30 V 92, Kaveri 50 and BHM 9 were studied at RARS, Rahmatpur, Barisal during the Kharif-1 season of 2016 to observe the performance of the hybrids under optimal temperature. Considering plant height, ear height, earliness and yield entry ZH16822 in trial 16S_DEIIYW-16; entry ZH169, ZH138098, ZH15440 and ZH15439 in trial 16S_AHSIII-112; entry VH112944, ZH15433 and ZH1610 in trial 16S_AHSIII-212; entry ZH15302 and ZH1680 in trial 16S_ASHII-112 and entry ZH141592 in trial MLT 151 were found promising and selected for further evaluations in across agro ecologies.

Phenotyping of HTMA hybrids under heat stress condition at Ishurdi (8 sets)

The experiment composed of 8 sets of trials and a total of 285 hybrids from CIMMYT, India including six check varieties viz., BHM9, 981, 942, NK40, 30V92 and Kaveri 50 were evaluated at the Regional Agricultural Research Station, Ishurdi, Pabna during the kharif-1 season of 2016 to observe the performance of the hybrids under heat stress. Highest and lowest temperature was observed 38.0ºC and 29.9ºC, respectively, during the silking and early grain filling stage. Among the hybrids considering yield and other secondary traits contribute to heat stress tolerance the best hybrids were VH131167(8.07 t ha^{-1}) and ZH15439 (7.30 t ha^{-1}) in trial AHSIII-111; VH112944 (6.66 t ha^{-1}), ZH1612 (6.27 tha^{-1}), ZH1610 (6.18 tha^{-1}) and ZH15381 (6.07 tha^{-1}) in trial AHSIII-211; ZH15416 (7.23 t ha^{-1}), VH112859 (7.05 t ha^{-1}) and ZH15286 (6.93 tha^{-1}) in trial ASHII-111; ZH137413 (7.23 t ha^{-1}), ZH16840 (8.89 t ha^{-1}), ZH16856 (8.89 t ha^{-1}) and ZH16879 (8.07 t ha^{-1}) in trial DMIIYW-16; ZH16849 (6.34 t ha^{-1}) in trial DMIIYW-26; ZH15445 (8.48 t ha^{-1}), ZH138077 (8.03 t ha^{-1}), VH121076 (7.79 t ha^{-1}) and ZH111755 (7.66 t ha^{-1}), in trial TWH-16; ZH15381 (7.74 tha^{-1}) in trial MLT-141. These hybrids need to be evaluated further in across agro-ecologies.

Phenotyping of HTMA hybrids under heat stress condition at Jessore (12 sets)

A total of 855 CIMMYT, India developed hybrids including six checks were evaluated in 12 sets of trials at the Regional Agricultural Research Station, Jessore during the kharif-1 season of 2016 to evaluate the performance of test cross hybrids under heat stress. Highest and lowest temperature was observed 38.0ºC and 28.6ºC respectively, during the silking and early grain filling stage. Among the hybrids considering yield and other yield contributing traits including heat stress tolerance the best hybrids were entry VH12242 (10.20 t ha^{-1}) in trial 16S_AHSIII-110; entries ZH1611 (9.54 t ha^{-1}), ZH15433 (9.80 t ha^{-1}) and VH112944 (10.33 t ha^{-1}) in trial 16S_AHSIII-210; entries ZH141592 (9.37 t ha^{-1}), ZH1679 (10.42 t ha^{-1}) and VH131167 (10.64 t ha^{-1}) in trial 16S_AHSII-110; entry ZH15432 (10.05 t ha^{-1}) in trial 16S_ASHII-210 and entries ZH16273 (9.58 t ha^{-1}) and ZH16300 (9.80 t ha^{-1}) in trial 16S_DHTC-34; entry ZH16386 (9.74 t ha^{-1}) in trial 16S_DHTC-44 and entry ZH169 (10.83 t ha^{-1}) in MLT-139. These hybrids need to be evaluated further in across agro ecologies.

G. Production of New Hybrids

Production of single cross field corn hybrids through diallel mating design, line × tester method and North Carolina design II fashion

In hybrid maize development programme, documentation of outstanding single cross combination having high heterotic effect is one of the important aims and goals. There are various ways to develop different types of hybrids in maize. Combining ability analysis is one of the powerful tools in identifying the better combiners. Diallel mating design, line × tester method and North Carolina design II fashion provides an opportunity to evaluate the genotypes during development of inbreds. These designs are most suitable to find out additive and dominant genetic variances, heterotic hybrids and heterotic partners of inbred lines.

Total four sets of crosses following 8×8 and 7×7 diallel fashion (excluding reciprocal) were made at Gazipur, Rahmatpur and Jamalpur and produced total 22.88 kg F_1 seeds. Through line × tester method two sets of pop corn produced 4 kg F_1 seeds. Total 8.62 kg F_1 seeds were produced by 7×7 North Carolina Design II method. These F_1 seeds will be evaluated in the next rabi season to select promising one(s).

Production of promising selected hybrids, modified single cross hybrids and stress tolerant experimental hybrids of short statured, lodging tolerant, excess soil moisture and saline tolerant field corn, pop corn and baby corn

Seven sets of single crosses produced total 22.1 kg field corn, 6.1 kg popcorn and 5.4 kg baby corn F_1 seeds. Two sets of modified single cross produced 13.96 kg and 2.85 kg F_1 field corn and popcorn seeds, respectively. Total 9.8 kg stress tolerant experimental hybrids of short stature, lodging tolerant, excess soil moisture and saline tolerant of field corn seeds were produced.

H. Maintenance and seed increase of parental lines and hybrids seeds

Maintenance and seed increase of parental lines of BARI maize hybrids

Inbred lines are the prerequisite for the development of hybrids. The goal of inbred lines maintenance is to maintain the performance, appearance, and genetic integrity of the original lines.

Total 3.6 kg seeds from twelve inbred lines (BIL20, BIL-22, BIL 28, BIL 29, BIL31, BIL 77, BIL 79, BIL 106, BIL 110, BIL 113, BIL 114 and BML 36) of different BARI maize hybrids were obtained. Isolation was maintained for each inbred line At flowering stage, healthy disease free plants were selected and selfed by hand pollination. Mature selfed ears were harvested separately and dried for 4-5 days. Undesirable ears were discarded. A final selection was done based on grain colour, texture and row arrangement and stored for experimental use in the next rabi season.

Seed production of parental lines of selected BARI maize hybrids and promising BARI maize hybrids

In maize breeding programme, maintenance of parent lines is pre-requisite for maintaining the quality of the respective inbred lines. It is very important to increase large scale seed production of the parental lines for large scale hybrid (F1) seed production to meet the local demand. Total 3497 kg seeds of nine parental lines (BIL 28, BIL 213, BIL 214, BIL 215, BIL 216, BIL 217, BIL79, BIL 218 and BIL 157) of BARI released maize hybrids were produced in isolation at different locations during 2016-17.

BARI developed a number of promising hybrids. It is necessary to increase large scale seed production of the parental lines of promising hybrids for large scale hybrid (F_1) seed production to utilize in demonstration and adaptive yield trial across countryside. Total 1215 kg seeds of six parents (BIL 157, BIL 210, BIL 211, BIL 212, BIL 213 and BIL 218) of promising BARI maize hybrids were produced in isolation at different locations during 2016-17 for further use.

Seed production of BARI hybrid maize

Seed is the most important raw material for crop production. To popularize the released varieties, seed production is a pre-requisite for demonstration at farmer's field. So, the experiment was undertaken to increase seed stock of the BARI released hybrid varieties of maize to be used for demonstration and future use.

Total 2693 kg F_1seeds of 6 hybrids BHM7, BHM9, BHM12, BHM13 BHM14 and BHM15 were produced at different RARS & HQ in isolation condition maintaining 4:2, female and male plant ratio during rabi 2016-17.

I. Maintenance and seed production of open-pollinated varieties

Maintenance and seed production of BARI composite maize varieties

Normally composite varieties are lower yielder than hybrid maize variety. Inspite of this, its advantage over hybrid is that, farmers can keep their own seed and low inputs requirement in cultivating the crop.

Total 932 kg seeds of three BARI OPV's (BARI Sweet Corn 1, BARI Khoibhutta and BM7) were produced at different locations in isolation by open pollination maintaining 2:1 ratio of females and males.

J. Barley and Millets Improvement Programme

Hybridization of barley

Hybridization is one of the major techniques to create variability and to integrate one or more desirable characters from different sources (e.g. wild relatives, local cultivars) into an individual (existing popular variety).

Nine parental lines were crossed with three testers to develop early, high yielding hull-less barley variety. Among 27 crosses, 25 crosses produced seeds which will be used for confirmation trial in next year.

Evaluation and selection in different filial generations

Success of a hybridization programme depends on carefully handling of segregating materials. It is often desirable to discard poor cross combinations in early generation, so that adequate attention can be paid to really potential combinations. The main objective of handling segregating generations is to grow and select the desirable families and individual plants in different filial generation for further evaluation.

In different segregating generation, selection was done based on earliness, short stature, hull-less and high yield. In F_1 generation, 1 plant from 1 cross, in F_3 generation 50 plants from 2 crosses, in F_4 generation 17 families, in F_5 generation 4 families & in F_6 generation 3 families were selected.

Preliminary, advanced and regional yield trials of hull-less barley

Through preliminary yield, six barley genotypes along with one check variety (BB-7) were evaluated in three different locations namely Gazipur, Ishurdi and Jamalpur in RCBD with 3 replications. The AMMI model (additive main effects and multiplicative interaction) was used to analyze the genotype-environment interactions over three locations to select the barley genotypes with higher yield and other potential attributes. Considering earliness, yield and yield contributing characters 2 barley genotypes performed superiorly and Ishurdi was proved as the best environment for barley cultivation.

Four genotypes along with one check variety of barley were assessed in advance yield trial for genotype environment interaction (GEI) and stability for selection of the best barley lines at three different locations namely Gazipur, Jamalpur and Ishurdi. The AMMI (additive main effect and multiplicative interaction) model was used to estimate the genotype-environment interaction over three locations to select the barley lines having higher yield and other potential attributes. Check entry BARI Barley-7 exhibited higher yield and as well as stable over all environments. Genotype INBONL-21/15 and Atabapha12 were high yielding for specific location.

Regional yield trials ensure the varietal suitability for specific location. Five barley lines including one check viz. BB-7 were evaluated across three different locations viz. Jamalpur, Gazipur and Ishwardi to find out the suitable genotypes. From the overall mean yield and other desirable characters the entry BHL-10 was found suitable across locations.

International barley trials

International naked barley yield trial (INBYT-HI) and observation nursery (INBON)

25 barley genotypes of international naked barley yield trial were evaluated at Gazipur to find out the suitable genotypes for large plot yield trial. Among the genotypes, entry 21 was early (94 days). Entry 23 exhibited the highest yield (2.95t/ha) followed by entry 6 (2.47 t/ha), entry 8 (2.01t/ha), entry 7 and 11 (1.93 t/ha).

International naked barley observation nursery was conducted at Gazipur. Ninety four hull-less barley lines received from ICARDA along with one standard check BARI Barley-7 was evaluated to select better performing hull-less barley lines. There were 50 lines with two rows and 44 lines with six rows among the genotypes. Considering earliness, yield and yield contributing characters 6 lines were selected from the 94 barley lines for preliminary yield trial.

International barley observation nurseries-high input

Barley is an important cereal crop used as human food, feed for animals, malt, and beverage. ICARDA has developed many new improved barley varieties, genotypes and advanced lines which are adapted to many different environments. Every year they are evaluating the developed lines to test their better performance across the world. Last year ICARDA provided some advanced barley lines to identify suitable lines under Bangladesh condition.

One hundred and twelve barley entries including one check (BB-6) were evaluated at Gazipur to select better performing barley lines. Considering earliness, yield and yield contributing traits (line 3, 4, 5, 11, 43, 46, 57, 58, 76, 77, 87, 94, 101, 107, 108 and 109) were selected for future breeding programme.

Adaptive trials with BARI barley varieties and advanced lines in southern belt and barind areas

Two sets of four BARI barley varieties (BARI barley-4, BARI barley-5, BARI barley-6 and BARI barley-7) and one advanced lines (BHL-15) were evaluated at Harodda, Vorma and Satkhira to observe the performance of BARI barley varieties in dry and saline areas. The highest grain yield (2.58 t/ha) was recorded in BARI barley-5 and lowest grain yield (1.82 t/ha) recorded in BARI barley-4 in set-I. The highest grain yield (2.41 t/ha) was recorded in BARI barley-5 and lowest (1.74 t/ha) in BARI barley-4 in set-II. The lowest level of soil salinity was recorded in sowing time (4.12 dS/m) and the highest level of salinity (10.76 dS/m) was recorded at the harvesting stage in set-I and the lowest level of soil salinity was recorded in sowing time (4.25 dS/m) and the highest level of salinity (11.05 dS/m) was recorded at the harvesting stage in set-II.

Four BARI barley varieties viz. BARI barley-4, BARI barley-5, BARI barley-6 and BARI barley-7) and three advanced lines (BHL-15, BHL-17 and BHL-21) were tested in saline areas of Noakhali. Among the tested varieties highest yield was found in BARI barley 7 (1.40 t/ha) followed by BHL-15 (1.39 t/ha) and BARI barley 6 (1.38 t/ha). The yield of barley varieties were low in comparison to their yield potentially might be due adverse effect of salinity during reproductive stage. At this stage rain was occurred several times with small amount which stimulated salinity progression when temperature raised.

Seven BARI barley varieties that BARI barley-1, BARI barley-2, BARI barley-3, BARI barley-4, BARI barley-5, BARI barley-6 and BARI barley-7 were evaluated at MLT site Koyra, Khulna during rabi season 2016-17 to test the seven BARI barley varieties. Among the tested varieties BARI barley-5 produce the highest yield (2.13 t/ha) and lowest yield was produced by BARI barley-3 (1.74 t/ha).

Three advance lines viz., BHL-19, BHL-25 and BHL-26 and two barley varieties namely BARI Barley-5, BARI Barley- 6 as check were evaluated at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi with a view to select high yielding barley advance lines for drought areas. Out of five barley varieties/lines BHL-19 gave the highest grain yield (2.19 t ha^{-1}) followed by BARI Barley-6 (2.08 t ha^{-1}). The lowest grain yield was produced by BHL-25 (0.98 t ha^{-1}). Considering the yield and yield contributing characters BHL-19 is the suitable one for Barley production in High Barind Tract.

Adaptive trials with BARI kaon varieties in southern belt and hilly areas

Two sets of three kaon varieties (BARI kaon-1, BARI kaon-2 and BARI kaon-3 (dwarf variety) were evaluated Benarpota, Satkhira to observe the performance of BARI kaon varieties in dry and saline areas. The highest grain yield was (2.77 t/ha) recorded in BARI kaon-3 and lowest (2.45 t/ha) in BARI kaon-1 in set-I. The highest grain yield (2.54 t/ha) was recorded in BARI kaon-3 and lowest (1.54 t/ha) in BARI kaon-1 in set-II. The lowest level of soil salinity was recorded in sowing time (4.00 ds/m) and the highest level of salinity (10.82 dS/m) was recorded at the harvesting stage in set-I and the lowest level of soil salinity was recorded in sowing time (4.05 dS/m) and the highest level of salinity (11.00 dS/m) was recorded at the harvesting stage in set-II.

Three BARI kaon varieties (BARI kaon-1, BARI kaon-2, BARI kaon-3) were evaluated at Kyamlong para hill valleys in Bandarban to compare the performance of BARI developed kaon varieties. Among BARI kaon-2 gave the highest yield (1.86 t/ha) followed by BARI kaon-1 (1.75 t/ha).

Breeder seed production of barley and millets

Barley and millets (kaon, cheena) are considered as minor cereals of Bangladesh. Minor cereals are consider as a short-season, early maturing annual grain crop with some degree of tolerance to drought and salinity, which allows its production in a wide range of climatic zones including both irrigated and dry land production areas. But only a few released varieties of barley and millets are available in the country. To maintain the varietal purity and maintenance breeder seed production is the pre-requisite for suitable crop production.

Total 408 kg breeder seed were produced from seven barley varieties viz. BARI Barley 1, BARI Barley 2, BARI Barley 3, BARI Barley 4, BARI Barley 5, BARI Barley 6 and BARI Barley 7 and 130 kg breeder seed of Kaon and Cheena were produced at four locations during 2016-17.

Advanced yield trial of foxtail millet

Four genotypes along with one check variety of foxtail millets viz. BARI Kaon-2 was assessed for genotype environment interaction (GEI) and stability for selection of the best foxtail millet lines in three different locations namely Gazipur, Jamalpur and Ishurdi. The AMMI (additive main effect and multiplicative interaction) model was used to analyze the genotype-environment interaction over three locations to select the barley genotypes having higher yield and other potential attributes. Among the tested foxtail millet lines Ise-1820 exhibited higher yield and as well as stable over all environments. Genotype Ise-710 and BK-2 were high yielding for specific location.

Preliminary yield trial of finger millet

Millets are considered as minor cereals of Bangladesh. It can be cultivated easily with low input in the char areas of Bangladesh. Millets can play partial role in fulfilling the food crisis of our country. But only a few released varieties of millets are available in the country. Therefore the improvement of yield potentiality and adaptability were major objectives of finger millet breeding programme.

Seven finger millet lines were evaluated across two location viz. Jamalpur and Rangpur to find out the suitable genotypes for large plot yield trial. From the overall mean yield and other desirable characters the entry Ie-501and Ie-2619was found comparatively suitable across locations.

Maintenance and seed increase of pearl millet, sorghum and proso millet germplasm

Germplasm are the main building blocks of variety development. Maintaining seed purity by rouging off type, diseased and weak plants is most important in plant breeding. Again, availability of enough seed is pre requisite to conduct various breeding programme to develop superior variety.

Total 4.1 kg seeds were produced from 9 selected pearl millet germplasm for next year trial. From seven selected sorghum germplasm total 18.2 kg seeds were produced. Total 13.07 kg seeds were produced from 21 exotic and locally developed proso millet lines for future breeding programme.

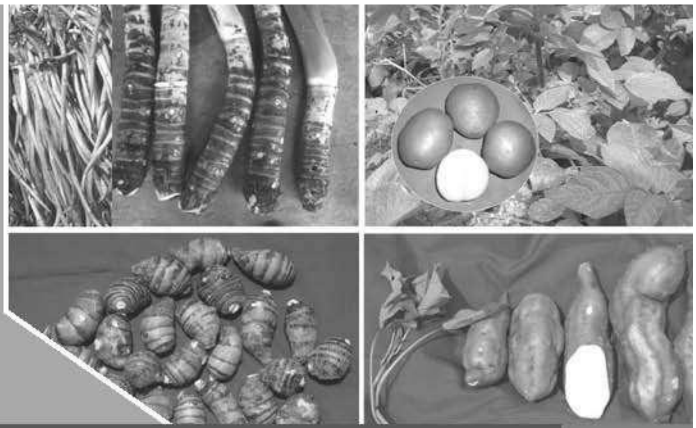
K. Technology Transfer Activities

Farmers, Government and NGO personnel were trained to make them familiar with the new maize varieties, modern crop management practices, seed preservation techniques and mechanization in maize cultivation. Training programme for farmers, extension officers, young scientists, maize field staffs, NGO personnel and others were conducted through audio-visual aids, demonstrations, lectures, training classes, field days etc. by maize staffs.

During 2016-17 Plant Breeding Division of BARI arranged two batches training for SAAO, SSA, SA (60 persons), 35 batches training for farmer (1050 persons), 1 batch biometric training for scientist (30 persons), 1 batch molecular breeding training for scientists, NGOs and seed companies (30 persons), hybrid maize production for Upazilla and district level officers of DAE and scientists 4 batches (120), hybrid maize seed production and parent lines maintenance for BADC officers, NGOs and seed companies 4 batches (60 persons). A training on 'Digital data capture and processing' was jointly organized by PBD, BARI and CIMMYT under Heat Tolerant Maize for Asia (HTMA) project where 40 participants had taken part from BARI and 5 leading seed companies (BRAC, ACI, Lal Teer, Supreme seed and Krishibid Group). This division also arranged ten training programme on minor cereal production for SAAO, SA and SSA (300 persons) and Farmers for 30 batches (900 persons).

A group of scientists and DAE personnel visited the demonstrations and seed production plots several times and were impressed to see the plots. A good number of visitors both from home and abroad, and students from different college and universities visited the experimental field and laboratory of PBD. Research activities of PBD were presented to them during their visit. Five field days were organized by PBD, Gazipur in seed production and block demonstration plots at Comilla, Faridpur, Kishoreganj, Khulna and Sherpur where about 300 farmers and local representatives were present. Plant Breeding Division also executed two field days on kaon at Munshiganj and Sherpur where 120 farmers and local representatives were present. Plant Breeding Division also arranged on-farm demonstration trials at Comilla, Faridpur, Kishoreganj, Khulna, Sherpur, Patuakhali and Rajshahi.

2 TUBER CROPS



Potato

Varietal Development

Hybridization in Potato

Potato is one of the most promising crops in Bangladesh due to its high productivity, short duration and wide adaptability. Potato research and development of HYV potato was started regularly in 1960, its varietal improvement has only been limited to introduction and selection until the year 2000 due to lack of initiatives. Potato plants do not flower under the short day conditions of Bangladesh. In the recent years, hybridization has been made possible at the TCRC after long lasting efforts on variety selection under extended photoperiod and use of flower induction techniques. Several treatments like extension of photoperiod, brick planting, stem girdling, grafting on tomato and use of hormones, alone or in combination, have been found effective in inducing flowers and berry setting in potato. Hybridization was done at Debigonj and Joydebpur using 132 and 118 genotypes/ varieties, respectively under 16 hours extended photoperiod to create variability, and for the selection of desirable genotypes. At Joydebpur, 223 out of 626 crosses and at Debigonj, 340 out of 810 crosses produced berries. In total 300 g hybrid seeds were produced of which 135 g was at Joydebpur and rest at Debigonj.

Production of seedling tubers of the potato hybrid (F_1C_0) population

Hybrid seeds which were produced in 2015-16 at Gazipur and Debiganj were sowed at Breeder Seed Production Centre, Debiganj on seedbed. Out of 527 crosses 441 were germinated and tubers of germinated crosses were harvested and stored for next year observation.

Selection of potato hybrids in subsequent clonal generations (F_1C_1, F_1C_2 and F_1C_3)

Clonal selection after hybridization is a continuous process of early generation. During the selection of hybrid seedling tubers of potato are subjected to further selection after field trials in each clonal generation. At the initial stage, clonal selection of potato is practiced only at BSPC, Debigonj due to favourable soil type and climatic condition. During selection planted potato clones are subjected to selection as single plant, plant row and single plot in subsequent clonal generations. In F_1C_1, F_1C_2 and F_1C_3 generations 147 potato clones weighing 1363 kg were selected and stored at BSPC, Debigonj for further evaluation.

Preliminary yield trial with clonal potato hybrids (F_1C_4)

Performance of 12 clonal hybrids and four checks BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) were evaluated at BSPC Debiganj, Panchagarh. Among the 16 genotypes, in case of marketable yield, the highest yielder (59.40t/ha) was clone 13.18 whereas the lowest yielder (36.22 t/ha) was check Granola. Among the genotypes all clones gave more yields over check varieties. Further study is required.

Secondary yield trial with F_1C_5 clonal hybrids of potato

Performance of 6 hybrid clones of potato was evaluated with check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix) and BARI Alu-28(Lady-Rosetta) in Debiganj, Gazipur and Jamalpur. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of potato. Among the six hybrid clones, clone 12.13 gave the significantly highest marketable tuber yield (27.29 t/ha) at 65 DAP. Clone 12.13 can be selected for commercial cultivation due to its higher tuber yield potentiality as early bulker. Clone 12.7 gave the statistically highest marketable tuber yield (61.55 t/ha) at Debiganj during final harvest which was statistically similar with the clone 12.20 (61.45 t/ha). The significantly average highest marketable yield (40.61 t/ha) was observed in also clone 12.7 which was identical to clone 12.8 (39.53 t/ha) and 12.20 (39.53 t/ha) whereas the lowest tuber yield (15.97 t/ha) was found in check Asterix at Jamalpur and in Granola at Gazipur and lowest average marketable yield (22.57 t/ha) was found in another check Lady Rosetta. Clone 12.7, 12.8 and 12.20 can be selected for commercial cultivation due to its higher tuber yield potentiality. In case of early maturity and dry matter percentage no clone performed better than checks. Therefore no clone was selected in those regards. Clone 12.8 performed better than check regarding taste, appearance and texture of boiled potato. Finally clone 12.8, 12.7, 12.20 and 12.13 can be selected for AYT on the basis of field performance and organolaptic taste.

Advanced yield trial of clonal hybrids of potato

Six clonal hybrids of potato were evaluated at five locations during 2016-17 for seventh generation. Data on marketable tuber yield at 65 DAP was recorded to identify the early bulker genotypes. The highest yield was found (40.03 t/ha) with clone 11.93 at Bogra. But, clone 11.93 performed the best average yield (25.83 t/ha) over the locations. However, all the tested clones performed more than 20 t/ha and tested clone did not differe conspicuously from checks regarding early bulking. Clone 11.68 gave the highest tuber yield (49.63t/ha) at Bogra. The average highest yield (37.33 t/ha) was observed in clone 11.50 which was similar with clone 11.80 (36.67 t/ha). Clone 11.93 and 11.80 both were prone to cracking and softrot due to rising soil temperature during harvesting. Other tested clones did not cross the bench mark yield which was our target. At final harvest, dry matter percentage was the highest with check variety Lady Rosetta (24.65) at Munshigonj. Considering the average over locations, BARI Alu-28 (Lady Rosetta) again gave the highest percentage of dry matter (22.52) as well while tested clone was far lower content dry matter. Those cannot be selected as processing. Clone 11.68 and 11.77 both the clone with blue coloured skin. It was assumed, those clone may content anthocyanin which is good for human health. Therefore,clone 11.68 and 11.77 can be selected for commercial cultivation due to its colour of skin to satisfy the consumer or after testing anthocyanin.

Regional yield trial of clonal hybrids of potato

Two clonal hybrid of potato namely 10.116 and 10.245 along with check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) were evaluated at six different agro ecological environment/locations during 2016-17 cropping season in RYT. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of potato. The clonal hybrid 10.116 yielded the highest (33.95 t/ha) followed by BARI Alu-7 (28.23 t/ha) and 10.245 (27.71 t/ha) at 95DAP. So, considering the yield in farmers' field trial, post-harvest, processing, disease and insect data both clonal hybrids were recommended for the release as commercial variety (s).

Participatory variety selection of clonal hybrids

The selected clonal hybrids with check varieties were evaluated at farmer's field under participatory variety selection to understand the performance as well as farmers opinion. On the average of six locations, both the tested hybrid clones produced higher yield than check varieties. The highest average tuber yield 38.54 t/ha was recorded in hybrid clone 10.116 followed by hybrid clone 10.245 (35.73 t/ha) and BARI Alu-7 (Diamant) (32.05 t/ha). The lowest yield (30.88 t/ha) was recorded in BARI Alu-28 (Lady Rosetta). Most of the farmers were very much interested for both the clonal hybrids 10.116 and 10.245 for their size, shape, color but varied location to location.

Preliminary yield trial of exotic potato varieties in first generation for table and processing purposes

Potato variety development through hybridization and selection is common and popular in potato growing countries. As, it is a crop of cooler region, long day condition is required for flowering. But, in Bangladesh such condition does not prevail in all locations. So, variety development through hybridization and selection is a tedious job and takes more time. In that case to release a variety within a short period through introduction is skillful. Eight exotic potato genotypes namely Actrice Cereza, HERMOSA, HZ03-2290, Margarita, Messi, Picobella, and SUN RED with four check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix), and BARI Alu-28 (Lady Rosetta) were evaluated at Joydebpur, Munshigonj, Jessore, Bogra, Debigonjand Jamalpur during 2016-17.Combined analysis of variance showed highly significant difference between the genotypes, locations and GEI for all the characters studied. The highest marketable tuber yield 39.99 t/ha was recorded in Cereza at Debiganj. This genotypes also showed highest average marketable yield (28.67 t/ha) all over the Bangladesh which was statistically similar with Messi (28.43 t/ha). On the other hand HZ03-2290 gave lowest marketable tuber yield (11.11 t/ha) at Jamalpur which was statistically similar with Margarita (11.20 t/ha). This Margarita genotypes also showed lowest average yield (20.23 t/ha) all over the locations of Bangladesh. The genotype SUN RED and Messi gave highest amount of average non-marketable tuber yield (3.93 t/ha) and (3.83 t/ha). All the exotic varieties showed satisfactory marketable yield as first year trial. Considering the overall yield and other characters all the genotypes may be selected for further evaluation in the next year.

Secondary yield trial of exotic potato varieties for table and processing purpose

Eight exotic varieties along with four check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix) and BARI Alu-28 (L. Rosetta) were evaluated at six different agro ecological locations (Bogra, Debiganj, Gazipur, Jamalpur, Jessore and Munshigonj) during 2015-16 for second generation trial. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of potato. The genotype Colomba gave the significantly highest marketable yield (38.28 t/ha) at 65 DAP in Debigonj which was statistically identical with the same variety (36.42 t/ha) at Munshigonj and Fortus at Debigonj. Colomba and Fortus also gave highest average marketable yield (27.43 t/ha) and 26.96 (t/ha), respectively. These two varieties can be selected for commercial cultivation due to its higher tuber yield potentiality as early bulker. Exotic variety Colomba gave the statistically highest marketable yield (53.46 t/ha) at Debiganj during final harvest. This variety also gave significantly average highest yield (33.56 t/ha) which was identical to Fortus (33.75 t/ha), whereas the lowest average yield (16.78 t/ha) was found in Ivory Russet. Colomba and Fortus can be selected for commercial cultivation due to its higher tuber yield potentiality. In case of early maturity and dry matter percentage no clone performed better than checks. Therefore no clone was selected in those regards. Zina Red and Carolus performed better than check regarding taste, appearance and texture of boiled potato. On the basis of disease data Alouette and Carolus can be selected for late blight disease tolerant. Finally Exotic variety Colomba, Fortus, Zina Red, Carolus and Alouette can be selected for AYT on the basis of field performance and organolaptic taste.

Advanced yield trial with exotic potato varieties for table and processing purpose

Seven exotic varieties were evaluated at five locations during 2016-17 for third generation. Tuber yield at 65 DAP was recorded to identify the early bulker genotypes. The best average yield (28.08t/ha) performed by 7four7 over the locations and it was assumed 7 four7 good for early bulker. There were no early mature exotic varieties and all the tested varieties were matured in between 85-95 days. A final harvest, the highest average yield (38.70) over the locations was found in 7four7 Cimega (37.33) and Memphis (36.67) also gave higher yield too. On the other hands, from scientist' observations, Farida is very susceptible to softrot during harvesting as well as after bring out from cold storage, it might be caused of higher number of over suze tubers. In case of Taisiya, it is also observed that this variety gave higher standard of tuber size and shape, it can consider for better tested variety too. All the tested varieties gave in between 18 - 20% dry matter content which might be acceptable for table potato but not for processing. From the AMMI stability analysis, Cimega and 7four7 were the highly stable with higher yield on the other hand, Taisiya and Memphis were also stable varieties as well. Therefore, Cimega, 7four7, Taisiya and Memphis may be selected for Regional Yield trial.

Regional yield trial with exotic potato varieties

Two exotic table potato varieties namely Camel and Verdifor table and processing potato along with check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granula) and BARI Alu-28 (Lady Rosetta) were evaluated at six different agro ecological environments/locations during 2016-17 cropping season in RYT. Due to unavoidable circumstances germination percent of tested exotic varieties was very poor for that data compilation and reporting on results and discussion of this experiment drop this year. Considering the observation, exotic variety Verdi proceed/forwerded the next year RYT as a processing variety but variety Camel is rejected for further evaluation.

Participatory variety selection of exotic potato varieties

Two exotic table potato varieties namely Camel and Verdifor table and processing potato along with check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) were evaluatedat farmers' field of six different agro ecological environments/locations during 2016-17 cropping season in PVS. Yield of two tested new exotic varieties varied significantly between locations to location. Some cases more than double yield obtained one location compare to another location. Farmer's perception was also varied. For that both the tested exotic varieties need to be test further for conformation.

Observation trial with clonal hybrids and exotic varieties against natural high temperature stress for early planting

Farmers in the northern part of Bangladesh cultivate potato using BARI released varieties which are not suitable for that climatic condition. Therefore, they do not get optimum yield and sufficient economic benefit. Another point is that farmers of north Bengal cultivate potato two times within the season. Although our released varieties are not suited perfectly in that region but they still cultivate by gaping one crop production to make up cropping pattern. Under this circumstances, early planting variety (early heat tolerant) development is an essential task. Therefore, development of early and heat tolerant variety and short duration (80 Days) were the objectives into consideration regarding this experiment. Heat tolerant yield trial was conducted at BSPC, Debigonj during rabi season 2016-2017. 20 exotic varieties and two checks, BARI Alu-13 (Granola) and BARI Alu-41 (5.183), were studied. 7four7, Cimega, Farida and taisiya gave higher yield than checks. These 4 genotypes need to be further study.

Selection of heat tolerant potato varieties for early planting

Observational yield trial against high temperature stress was conducted at BSPC, Debigonj during rabi season 2016-2017. Seven potato varieties, those areBARIAlu-46 (LB-7), BARI Alu-47 (7.12), BARI

Alu-51 (Bellarossa), BARI Alu-52 (Labadia), BARI Alu-53 (LB-6), BARI Alu-58 El Mundo), BARI Alu-59 (Metro), gave the higher yield than both the checks. Those varieties need to intensive heat tolerance test to confirm.

Screening of the potato variety for export potential

The present consumption of potato estimates 7.0 million tons, seed requirement 0.8-1.00 million tons and processing factory use 0.1 million tons. The rest >1.5 million tons was surplus. Farmers sometimes face serious losses due to this glut in the market. So they get discouraged in potato cultivation, which can't be entertained in a food nutrition deficit country like Bangladesh. So we need to export this surplus potato to foreign country. Some of the exporters claimed that we have no sufficient technology for production of exportable potato. Suitable Variety is one of them. The requirement of export potato variety as well as production technology is different in our traditional table potato production. So, the present study is therefore undertaken to identify the suitable potato varieties for export with a view to sustainable potato production in the country. Thirty four released potato varieties were evaluated at three different agro ecological environments/locations during 2016-17 cropping season for selecting export suitability of the variety. Tuber yield and grading by percent number and weight revealed that among the tested varieties varied significantly between the locations and within location. Post-harvest data collection is not yet been completed, which is one of most important criteria for selecting exportable potato variety. This is the first year trial; minimum three years data needs to select suitable variety (s) for export.

Screening of CIP potato clones for heat tolerance

Thirteen CIP bred potato clones with two check variety Asterix and Granola were assed for heat tolerance following split plot design with randomized complete blocks (RCB) arrangements replicated thrice in the experimental field of Tuber Crops Research Sub-Centre, Bangladesh Agricultural Research Institute, Bogra, in non-stress (Standard/non-stress planting on 20 Nov. 2015) and heat stress (Late planting on 20 Dec. 2015) conditions during 2016-17 cropping season. In heat stress condition, all growth yield and yield contributing characters like plant height, stem per hill, canopy coverage (%), plant vigor and tuber number per plant, weight of tuber per plant, yield (ton/ha) were decreased compare to non-stress condition. CIP-118 (43.09 ton/ha) was the highest yielder followed by CIP-112 (42.61 ton/ha), CIP-232 (40.84 ton/ha), CIP-221 (39.51 ton/ha), and CIP-127 (38.19 ton/ha) under non-stress and while under heat stress condition CIP-232 (37.47 ton/ha) was the highest yielder followed by CIP-112 (34.33 ton/ha), LB-7 (33.22 ton/ha), CIP-139 (31.21 ton/ha) and CIP-232 (31.02 ton/ha). From the results, it was found that more than 30 ton/ha yield was harvested from CIP-112, CIP-118, CIP-139, CIP-203, CIP-229, CIP-232 and LB-7 at both conditions with a reduction of 19.43%, 28.99%, 15.85%, 15.48%, 15.17% and 10.84% respectively under heat stress condition. To select the potato genotypes more preciously for heat stress (late plantation), several indices were applied and ranked the genotypes accordingly. According to heat stress indices, among the fifteen potato genotypes, CIP-139, CIP-218, CIP-112, CIP-205 and CIP-203 were identified as the heat tolerant potato genotypes.

Participatory advanced yield trial of CIP processing qualities potato clones through mother & baby trial design in Bangladesh

Four CIP advance potato clones with three improved potato varieties, Diamant, Asterix and Lady Rosetta were included in the Advance Yield Trial during 2016-17 for growth, yield and postharvest processing quality study at six locations namely: Bogra, Debigonj, Jamalpur, Jessore, Joydebpur and Munshigonj. In the trial, at Jessore research stations and farmers' fields, The crop was evaluated in two stage namely, vegetative and harvesting stage. Results showed that at vegetative stage in mother trial, according to global score CIP-224 ranked 1st followed by CIP-225, Diamant, CIP-239 and CIP-218. Considering global score at harvesting stage in mother trial, CIP-239 performed as best followed by CIP-224, CIP-218 and CIP-225. Considering the mean of all locations, CIP-218 was the highest yielder followed by CIP-225, CIP-224 and CIP-239. CIP-218 which had produced 38.69%, 36.33% and 66.80% higher yield compare to the check variety of Diamant, Asterix and Lady Rosetta, respectively. Through organoleptic evaluation on appearance, texture and taste at Jessore location, CIP-224, CIP-239, CIP-225 and CIP-218 were found promising.

Participatory variety selection trial with CIP promising clones of virus resistance and abiotic stress tolerance

The seed potato infected with PVY and PLRV seems to be degenerated following the successive generation. This is also an acute problem of seed potato production in Bangladesh and in case of severity, both these diseases can reduce tuber yield by up to 78% and 85%, respectively. The possibility to ensure the high yield of potato remains to a great extent with management of viruses and it is very easy to overcome the problem if we would have any variety tolerant to viruses with high yield potential. Considering these facts, the present experimental trial has jointly been undertaken by the International Potato Center (CIP) and Tuber Crops Research Center (TCRC) of BARI to evaluate the performance of CIP potato clones' tolerance to virus diseases. An advance varietal selection trial was conducted with one virus resistant and one abiotic stress tolerant potato clones of CIP against 2 check varieties Diamant and Asterix at 6 locations of Bangladesh during 2016-17 crop season for their suitability and yield potentiality. Vigorous growth was recorded in all CIP clones at all locations. Other morphological characters like canopy coverage and stem per hill showed significant variation among the clones across the locations. Yield (ton/ha) varied significantly at all locations and ranged from 21.07-53.16 ton/ha. The mean highest yield was recorded in CIP- 10 (42.07 ton/ha) and the lowest was in the check variety Asterix (30.28 ton/ha). Considering the yield performance over the locations and disease reactions of two CIP clones in the present study, CIP-10 (CIP 397029.21) and CIP-102 (CIP 391029.18) were found promising that could be released as virus resistance and abiotic stress tolerant potato variety in Bangladesh.

Morphological characterization and photographic documentation of advanced CIP potato clones

Morphological characterization is essential for recognizing, distinguishing and describing a variety. The central theme is identification of a variety through the use of some parameters of characterization. Precise information about the extent of genetic divergence and on characters used for discrimination among the population is crucial in any crop improvement program, because selection of plants based on genetic divergence has become successful in several crops. In recent years a number of newly developed advanced breeding lines have been added to the germplasm collection. Therefore, the parents to be used in breeding improved potato cultivars to grow in these contrasting growing conditions ought to be different. No information regarding the extent of genetic divergence in these newly acquired potato lines, is available under this condition. In view of the above, the present study has been undertaken to collect information on genetic divergence in the newly acquired genotypes so that useful parental materials for the breeding program could be selected. Ten advanced clones of CIP were characterized at Breeder Seed Production Centre (BSPC), Bangladesh Agricultural Research Institute (BARI), Debigonj and Tuber Crops Research Centre (TCRC), BARI, Joydebpur, Gazipur, during winter in 2016-17 following the DUS (Distinctness, Uniformity and Stability) descriptor which is approved by the National Seed Board of Bangladesh; descriptor of CIP, Peru and FDDP (Field Data Descriptor of Potato) of TCRC. There were observed the morphological characteristics in addition agro-morphic characters too. Large variation was found among the genotypes and distinct characters were recorded which could be help to find out the respective clones as well. Furthermore, lot of information were identified which could provide important information to the breeders.

Morphological characterization of advanced breeding lines of potato

Seven advanced clones of potato developed from own crossing program of TCRC and eight exotic varieties were characterized at BSPC, Debigonj during winter in 2016-17 following the DUS (Distinctness, Uniformity and Stability) descriptor which is approved by the National Seed Board of

Bangladesh and descriptor of CIP, Peru. There were observed the morphological characteristics in addition agro-morphological characters too. Large variation was found among the genotypes and distinct characters were recorded which could be help to find out the respective clones as well. Furthermore, lot of information were identified which could provide important information to the breeders.

Maintenance of released potato varieties, germplasm, lines and TPS parents

Any variety, line, genotypes and land raceses considerd as germplasm which are very important for breeding point of view. Number of germplasm is also important for genetic base of the population. If the number is high the genetic base is high and contained high genetic pool. Some of the materials contained some valuable genes which are important for future breeding work. In that case Maintenance breeding is very much important for conservation as well as preservation of gene pool in future use. It is also necessary for breeding programme in our country, where the variability of potato is very low because potato is not a crop in this region. Maintenance breeding is the routine work of TCRC for future use of valuable materials. Potato needs to grow every year and stored in cold storage in our climatic conditions. Each and every year all the germplasm grown under net house in BSPC, BARI, Debigonj and after harvest stored in cold storage. This year also conduct the same experiment for this same purpose. A total of 1177 kg seeds of potato were preserved in Breeder Seed Production Center coldstore, Debiganj, Panchagarh collected from 242 potato variety/germplasm/hybrid clone during 2016-17.The preserved materials will be used in future for variety development programme.

Multiplication, purification and maintenance of indigenous potato varieties

Indigenous potato variety (IPV) contents higher proportion of amylopectin than EPV which make them sticky and testier. In spite of low yields, the IPV are popular among the growers and consumers mainly for containing higher percentage of dry matter and as such exhibit good keeping quality under ordinary temperature. Besides, IPV gives reasonable yield under low input condition and because of that, it fits well into the production system of small and marginal farmers. Due to farmers and consumers acceptability particular attention should be given to the maintenance and improvement of IPV. That's why these materials should be maintained and purified through clonal selection over the year. After purification each year yield performance should also checked with view to how much progress of yield compared to previous year. These were the objectives for this trial. Nine (9) cultivers namely Ausha, Challisha, Dohazari, Indurkani, Lalpakuri, Patnai, Shilbilati, Sindurkauta and Sadaguti planted during 2016-17. Off type and disease infested plants were roughed out from each plot 199 kg Clean Seeds of nine cultivars along with 74 kg from 34 seleted clonal have been stored at BSPC, BARI, Debiganj, Panchagarh cold storage for next year trial and maintenance purposes.

Cultural Practices

Effect of tuber grade and hilling height on the yield and quality of seed potato production for processing

The present study was carried out at Tuber Crops Research Sub-Center, BARI, Munshigonj during the winter of 2016-17 to determine the effects of tuber grade and hilling height on the yield and quality of seed potato (*Solanum tuberosum* L.) for processing purpose. It was observed that the foliage coverage, plant height, stems/hill, number and weight of tubers/plant varied significantly due to variation of tuber grade. The earliest days (12.00) to start emergence was found from the farmer's practice (plough pan layer) with medium and small graded whole seed tuber individually while vigorous (9.00) plants at 60 DAP were found in minimum hilling height (7.5 cm) with large and medium graded whole seed tuber individually. The highest number (11.67) and maximum weight of tubers/ hill (0.5473 kg) were found from the larger graded whole seed tuber with minimum (7.5 cm) and highest (10-12 cm) hilling height, respectively. However, the highest gross yield of tubers (36.88 t/ha) was observed from the treatment combination of medium grade seed tubers and medium hilling height while larger sized seed tubers with farmer's practice (plough pan layer) gave the maximum dry matter (20.08%).

Effect of different tuber grade and spacing on the yield and quality of seed potato production for processing

A field experiment was carried out at the research farm of Tuber Crops Research Station, BARI, Munshiganj, during *rabi* season of 2016-17 with three different tuber grade viz.G_1(40-55 mm), G_2(28-40m), G_3(<28mm) and four different spacing viz. S_1 (60 cm × 15 cm), S_2 (60 cm × 20 cm), S3 (60 cm × 25cm)and S_4 (60 cm × 30 cm) to find out appropriate tuber grade and plant spacing for better yield and quality seed production. Yield and yield contributing characters and most of the plant characters were significantly varied in case of main effects and the interaction effects. The highest yield (50.09 t/ha) was observed in treatment combination of spacing S_1 (60 cm × 15 cm) with grading G_2 (28-40m) while lowest yield (8.39 t/ha) was recorded in spacing S_1 (60 cm × 15 cm) with seed tuber grade G_1 (40-55 mm) interacting combination.

Crop Nutrition

Determination of fertilizer dose for newly released potato varieties

Nutrient management and variety were evaluated on potato yield and soil properties at Grey Terrace soil of Joydebpur and Non-calcareous Grey Floodplain soil of Debiganj. Three promising released potato varieties such as Asterix, Lady Rosetta and Sagitta were evaluated under different levels of fertilizer. The five fertilizer treatments were: T_1 (RDF), T_2 (125% RDF), T_3 (TCRC recommended dose of fertilizer), T_4 (80 % RDF + Poultry manure, PM@ 3t ha^{-1}) and T_5 (control, native nutrient). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Different fertilizer treatments and variety showed significant effect on the yield of potato over locations. The highest tuber yield (51.2 t/ ha) was found in 125% RDF which was statistically similar with T_4 (49.6 t/ha). In case of variety, Sagitta showed the maximum yield. Among the locations, the highest tuber yield was recorded in Debiganj. T_4 showed the highest marginal benefit cost ratio (MBCR) which was closely followed by 100% RDF. Nutrient uptake by the plant and soil fertility status will be presented after having analytical value of plant and soil samples. This is the second year findings and need repeat to verify the result.

Effects of organic manure and inorganic fertilizer on storability and nutritional quality of potato

Organic manure and chemical fertilizers were tested on quality components and storability of potato tuber under different nutrient management and to study the post-harvest soil properties at Grey Terrace soil of Joydebpur and Non-calcareous Grey Floodplain soil of Debiganj. There were six treatments - T_1 (Control, native nutrient), T_2 (100% recommended dose of fertilizers, RDF), T_3 (Poultry manure, PM@ 3t ha^{-1} + rest from RDF), T_4 (Cowdung, CD @ 6 t h^{-1}+ rest from RDF), T_5 (125% RDF) and T_6 (Farmer's practice, FP). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Yield of potato was significantly ($p \leq 0.05$) influenced by the integrated use of organic manure and chemical fertilizers. The highest potato tuber yield (41.7 t ha^{-1}) was found in 125% RDF at Debiganj. The maximum marginal benefit cost ratio was found in T3 (3 t PM ha^{-1} + rest chemical fertilizer from RDF). The highest nutrient availability was observed in T3. The minimum weight and rottage loss were found in 3 t PM or 6 t CD ha^{-1} + rest chemical fertilizer from RDF. Therefore, 3 t PM or 6 t CD ha^{-1} + rest chemical fertilizer from RDF was found to be suitable for sustainable potato production. The nutritional parameters will be presented after receiving the analytical data.

Effect of nitrogen rate and variety on the yield and quality of potato

Three newly released potato variety such as BARI Alu-31 (Sagitta), BARI Alu-41 (5.183) and BARI Alu-45 (Steffi) were tested under five levels of nitrogen (T_1 =100% RDN, recommended dose of nitrogen), T_2 =125% RDN, T_3 =150% RDN, T_4 =175% RDN and T_5 =75% RDN) at Breeder seed Production Centre (BSPC), Debiganj, Panchagarh during the Rabi season of 2016-2017. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The potato tuber yield was significantly variable among the treatments under different varieties. BARI Alu-41(5.183) was found superior than BARI Alu-31 and BARI Alu-45. The maximum dry matter (20.2%) and starch content (15%) were found in BARI Alu-41. The minimum scab infection was also noted in BARI Alu-41. Nitrogen application rate showed insignificant influence on tuber quality. The tuber yield was significantly variable among the nitrogen levels. The maximum tuber yield (47.7 t/ha) was found in 150% RDN followed by 125% RDN. The interaction effect of nitrogen and variety was not significant on tuber yield. Therefore, 150% RDN and BARI Alu-41 can be recommended for potato cultivation.

Effect of sulphur and variety on the yield and quality of potato

The experiment was carried out at Breeder seed Production Centre (BSPC), Debiganj, Panchagarh during 2016-2017 to study the effect of five levels of sulphur application on yield and quality of potato varieties. There were five treatments comprising different levels of sulphur such as T_1 (control, no sulphur), T_2 (75% RDS), T_3 (100% RDS), T_4 (125% RDS) and T_5 (150% RDS). Three newly released potato variety such as BARI Alu 36 (4.26R), BARI Alu -40 (4.45W) and BARI Alu- 25 (Asterix) were used as test crop. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The tuber yield and yield contributing characters were significantly influenced by the application of sulphur. The maximum tuber yield (40.1 t/ha) was recorded in BARI Alu-40. The highest dry matter content, specific gravity and starch content were found in BARI Alu-40, which was followed by BARI Alu-36. The tuber yield was increased with increase in sulphur level up to 100% RDS after that yield was declined. Therefore, 100% RDS can be recommended to produce BARI Alu-40 for higher yield and better quality.

Organic Cultivation

Evaluation of export oriented potato varieties under organic cultivation system

An experiment was conducted to evaluate the yield and quality of some export oriented potato varieties under organic management practices. The experiment was executed at the organic block under TCRC research field, Joydebpur during the year 2016-17. Ten export oriented varieties namely BARI Al-7, BARI Alu-8, BARI Alu-13, BARI Alu-25, BARI Alu-27, BARI Alu-35, BARI Alu-41, BARI Alu-44, BARI Alu-45 and BARI Alu-46 were selected as the treatment. These varieties were evaluated under organic production system where soil fertility were managed with different organic fertilizers like Cow dung, Vermicompost, Trichocompost, and Neem Oil Cake @ 5t/ha each and different botanicals were used to reduce the pest attack. The highest organic tuber yield (25.3 t/ha) was found from the variety BARI Alu-41 which was followed by BARI Alu-35 (24.9 t/ha) and BARI Alu-46 (23.8 t/ha) and were statistically identical. The highest dry matter (23.5%) as well as maximum cost benefit ratio (1.02) was obtained from the variety BARI Alu-41. Considering all aspects, BARI Alu-41, BARI Alu-35 and BARI Alu-46 could be brought under organic cultivation as export purpose for global organic market. This is the 2nd year findings and need repeat to verify the result.

Effects of different organic fertilizers on the yield and quality of potato processed products

This experiment was executed at the organic block under TCRC research field, Joydebpur during the year 2016-17 to assess the influence of organic fertilizers on the yield of potato and thereafter on the quality of potato chips and French fries. Performance of five organic fertilizers namely Cowdung, Mega Organic Fertilizer, Vermicompost, Trichocompost and North Bengal Organic Fertilizer with two potato varieties e.g. BARI Alu-25 and BARI Alu-28 were evaluated. After harvesting, 2 kg of potato from each treatment had been supplied to the post-harvest laboratory for assessing the quality of chips and French fries and data was recorded according to the specified method followed by TCRC. Mega Organic Fertilizer with BARI Alu-25 gave the highest yield (20.8 t/ha) which was at par with BARI Alu-28 (19.7 t/ha) treated with same fertilizer and both were identical but statistically different from most of the treatments. Quality of chips and French fries was found better from the Mega Organic Fertilizer with BARI Alu-27.

Pest Management

Disease Management

Survey of major potato diseases of Bangladesh

A survey work was conducted to observe the incidence of potato diseases in Bangladesh. Late blight disease incidence was relatively high in Jamalpur, Thakurgoan and low in Munshigonj, Mymensingh, Comilla, Chittagong, Jessore and Rajshahi. Common scab and mosaic were found as high incidence, whereas bacterial wilt, stem rot, early blight, stem canker, black scurf, black leg and PVY were found as less disease incidence of potato in Bangladesh.

Screening of CIP potato clones against soil borne diseases (common scab, stem canker and black scurf)

Common scab caused by *Streptomyces* spp. and stem canker & black scurf caused by *Rhizoctonia solani* are important disease of potato and found in everywhere in Bangladesh. Both diseases are seed and soil borne. *Streptomyces* spp. infects the tuber by invading the undifferentiated lenticels of the developing tuber. The infected areas of potato respond by producing a corky layer. During the initial stages of infection of *Rhizoctonia solani*, some lesions are observed on potato tuber sprouts, and sometimes death of these sprouts can be observed. Later in the season the most characteristic symptom of this disease, “black sclerotia”, can be observed on potato tubers. This disease decreases the progeny tuber quality as well as quantity. So, both pathogens are unspecialized parasite, survive in soil in the absence of host plant and make itself a very difficult pathogen to manage. Cultivation of resistant varieties is the most economic and environmentally safe method of crop disease management. It is most necessary to find out suitable varieties for commercial cultivation which are resistant to soil borne diseases. To fulfill this purpose a set of CIP potato clones were screened under natural inoculum pressure to know its status of susceptibility and resistance level to common scab and stem canker & black scurf**.** There were twelve CIP potato clones were evaluated against common scab and black scurf disease under natural field conditions with two BARI released potato varieties BARI Alu-8 and BARI Alu-29 as check at farmers' field, Khturia, Domar, Nilphamari during 2016-17 cropping season. Significant variation among the clones and varieties became well pronounced in tested parameters. No clones / checks were free from common scab. The range of common scab incidence and severity of CIP clones were 7.65 to 27.52 and 1.63 to 6.41 respectively while the significantly lowest disease incidence 3.65% and severity 0.72 was recorded from BARI Alu-29 (check). Only CIP clone 232 was free from black scurf disease. The significantly highest black scurf disease incidence (11.37) and severity (3.28) was in check BARI Alu-8 (Cardinal). The range of black scurf incidence and severity of CIP clones were 0.00 to 5.40 and 0.00 to 1.20 respectively. Significantly highest (45.12 t ha^{-1}) and lowest (22.74 t ha^{-1}) tuber yield was harvested from clone 239 and clone 223, respectively.

Screening of CIP potato clones against late blight disease

Potato late blight caused by fungus *Phytophthora infestans* is a devastating disease that causes yield losses annually about 30% in Bangladesh. BARI has released already 77 potato varieties using different sources but few of them are known its response to late blight. Keeping in view the economic and social importance of late blight disease, the present study was designed to screen 12 CIP potato clones against *P. infestans* under natural inoculum pressure for knowing late blight reaction of those clones before going to release the clone(s) as variety. During 2016-17 cropping season, screening of twelve CIP potato clones including check varieties (BARI Alu-8 and BARI Alu-25) against late blight (*Phytophthora infestans*) under natural inoculum pressure was carried out in farmers' field, Khaturia, Domar, Nilphamari. Results revealed that all clones including checks were highly susceptible to late blight except clone 235 was susceptible and the range of AUDPC values were 666.50 to 1424.00. The highest AUDPC value (1424.00) was recorded from clone 217. Clone 225 yielded the significantly highest (17.32 t ha^{-1}) which was significantly different from all others and the lowest in BARI Alu-25 (3.35 t ha^{-1}).

Screening of different released varieties against post-harvest disease under natural storage conditions

Performance of different potato varieties was assessed to post harvest rottage and weight losses at Joydebpur under natural storage conditions. The percentage of tuber rot due to disease and weight loss was increased with the increase of time under both conditions. Under natural condition, the tuber rottage were observed zero up to 120 days in the variety BARI Alu-13 (Granola) and found the lowest rottage up to 180 days. The variety BARI Alu-13 (Granola) showed the lowest tuber rottage followed by variety BARI Alu-34 (Laura), BARI Alu-42 (Agilla) and BARI Alu-7 (Diamant). In case of shelf life, BARI Alu-13 (Granola) gave the hight percentage of healthy tuber followed by BARI Alu-34 (Laura), BARI Alu-7 (Diamant), BARI Alu-44 (Elgar) and BARI Alu-17 (Raja) after 180 DAS for preservation. Considering all criteria, BARI Alu-13 (Granola), BARI Alu-34 (Laura) and BARI Alu-7 (Diamant) found to be better for long shelf life.

Screening of potato varieties against soil borne diseases (common scab, stem canker & black scurf)

There were twenty six potato varieties/germplasm were evaluated against common scab and black scurf disease under natural inoculum pressure at farmers' field, Khaturia, Domar, Nilphamari during 2015-16 and 2016-17 cropping season. Significant variation among the varieties became well pronounced in tested parameters. No varieties / germplasm was found immune to *Streptomyces* spp. BARI Alu-13 (Granola), BARI Alu-29 (Courage), BARI Alu-36 (4.26 R), BARI Alu-41, BARI Alu-46, BARI Alu-56, BARI Alu-59 (Metro) and BARI Alu-61 exhibit good level of resistance against common scab for both cropping seasons and out of these BARI Alu-59 was minimum affected where common scab incidence viz. 1.11% and 3.94% and severity viz. 0.39 and 0.80 was in 2015-2016 and 2016-2017 respectively. Eleven varieties like BARI Alu-13 (Granola), BARI Alu-35 (4.5 W), BARI Alu-36 (4.26 R), BARI Alu-40 (4.45 W), BARI Alu-41, BARI Alu-46 (LB-7), BARI Alu-53 (LB-6), BARI Alu-56, BARI Alu-59, BARI Alu-60 (Vivaldi) and BARI Alu-61 (Volumia) showed resistant against black scurf during both cropping seasons of them BARI Alu-60 (Vivaldi) and BARI Alu-61 (Volumia) were highly resistant i.e. there was no black scurf disease. Significantly highest (49.05 t ha^{-1}) and lowest (31.52 t ha^{-1}) tuber yield was harvested from BARI Alu-40 (4.45 W) and BARI Alu-29 (Courage) respectively in 2015-2016. In 2016-2017 cropping season, BARI Alu-13 (Granola) yielded the significantly highest 48.0 t ha^{-1} and lowest yield (24.17 t ha^{-1}) was from BARI Alu-60 (Vivaldi).

Screening of CIP potato clones against soil borne diseases (common scab, stem canker & black scurf)

There were twelve CIP potato clones were evaluated against common scab and black scurf disease under natural field conditions with two BARI released potato varieties BARI Alu-8 and BARI Alu-29 as check at farmers' field, Khturia, Domar, Nilphamari during 2016-17 cropping season. Significant variation among the clones and varieties became well pronounced in tested parameters. No clones / checks were free from common scab. The range of common scab incidence and severity of CIP clones were 7.65 to 27.52 and 1.63 to 6.41 respectively while the significantly lowest disease incidence 3.65% and severity 0.72 was recorded from BARI Alu-29 (check). Only CIP clone 232 was free from black scurf disease. The significantly highest black scurf disease incidence (11.37) and severity (3.28) was in check BARI Alu-8 (Cardinal). The range of black scurf incidence and severity of CIP clones were 0.00 to 5.40 and 0.00 to 1.20 respectively. Significantly highest (45.12 t ha^{-1}) and lowest (22.74 t ha^{-1}) tuber yield was harvested from clone 239 and clone 223, respectively.

Validation trial on integrated disease management against scab disease of potato

Three different field trials were conducted during 2013-14 for identifying resistant/tolerant varieties, effective seed treating and soil amendment agents for developing an effective integrated disease management (IDM) packages against scab disease of potato. Selected varieties and were BARI Alu-34

(Laura), BARI Alu-45 (Steffi), BARI Alu-41(5.183), BARI Alu-44 (Elgar), BARI Alu-13 (Granola), BARI Alu-25 (Asterix), BARI Alu-28 (Lady Rossetta) and BARI Alu-31 (Sagita); soil treating agents were Diathane M-45 @ 0.3%, Provax-200 @ 0.3% and Stable Bleaching Powder @ 0.5% and soil amendment agents were Boric acid @15 kg/ha, Cow dung @ 10 t/ha and Stable Bleaching Powder @ 30 kg/ha. In 2016-17, a field experiment was conducted to evaluatethe ten treatment combinations based on previously selected varieties and agents including one control against common scab disease of potato in the field laboratory of Gazipur, Bogra and Comilla. Among ten treatment combinations, irrespective of disease incidence and severity, seed treatment (ST) with Provax-200 @ 0.3% + soil amendment (SA) with cow dung @10 t/ha was found the most effective one. Second best combination was found ST with Diathane M-45 @ 0.3% + SA with CD @ 10 t/ha. In general, all others treatment combinations had significantly good influence for reducing scab disease of potato than control. Location had significant influence on scab disease of potato. Among the three locations, the highest disease pressure was found in Gazipur than other two locations. Based on previous results and current findings an IDM package is proposed for management of scab disease of potato in Bangladesh context.

Effect of different management practices on the common scab disease of potato

An experiment was conducted at TCRC, BARI, Gazipur to find out the effective management practices in controlling common scab of potato var. Diamant. A total of eleven (11) treatments including farmer practices were selected as different combinations of seed and soil treatments, using the different chemicals as Boric acid, Mancozeb, soil solarization, straw burning and different irrigation schedule. The effect of treatments varied among them to reduce common scab of potato. The treatment T_1 (Rice straw burning in the field) found to be more effective to control common scab based on disease the incidence and severity.

Integrated management of virus diseases in potato

An experiment was conducted to evaluate nine treatment combinations for managing virus diseases of potato during 2016-17 at the experimental field of TCRSC, Seujgari, Bogra. Effect of treatment combinations were varied significantly. Among them, T_4 {Barrier crop + Rouging + Spraying of Admire (@ 0.5ml/L, 4 times at 10 days interval)} showed the lowest virus diseases incidence and produced the highest yield and which was 42.41% higher than control.

Efficacy of new fungicides in controlling late blight of potato

A total of 22 fungicides were tested against late blight disease of potato at TCRSC, Bogra during robi season 2016-17. Results revealed that among the 22 fungicides only three (03) fungicides namely Robust, Lux curb 72 SL, Mezeb 80 WP showed excellent performance in controlling late blight disease.

Validation trail of promising fungicides against late blight of potato

A total of 18 fungicides were tested against late blight disease of potato at TCRSC, Bogra during Rabi season 2016-17. Among the fungicides only six (06) fungicides namely Secure, Nemispore 80 WP, Indofil, Cozeb 80 WP, Goldman 80 WP and Dithan M-45 were found very effective and rest fungicides were less effective in reducing the disease severity.

Screening of potato germplasm against late blight under natural field condition

The experiment was conducted at TCRSC, Bogra under natural field condition during rabi season of 2016-17. It was found that among the 15 varieties/germplasm, only two (Aloutte and Carolus) showed resistant reaction, one showed moderately resistant and rest of all susceptible to *Phytophthora infestans.*

Screening of potato varieties and germplasm against late blight disease

Late blight of potato, caused by *Phytophthora infestans* (Mont.) de Bary, is one of the most important diseases of potato (*Solanum tuberosum*L.) in Bangladesh. Field experiment was conducted under natural inoculum pressure in farmers' field, Khaturia, Domar, Nilphamari to evaluate fourteen potato varieties/germplasm against late blight disease in 2016-2017 cropping season. None of the variety/germplasm was found immune. Four varieties like BARI Alu-46, BARI Alu-53, BARI Alu-57 and BARI Alu-77; and two germplasm viz. Alouette and Carolus found highly resistant. The highest yield (48.38 t ha^{-1}) was recorded from BARI Alu-46. Alouette and Carolus yielded 36.58 t ha^{-1} and 35.91 t ha^{-1} respectively.

Screening of CIP potato clones against late blight disease

During 2016-17 cropping season, screening of twelve CIP potato clones including check varieties (BARI Alu-8 and BARI Alu-25) against late blight (*Phytophthora infestans*) under natural inoculum pressure was carried out in farmers' field, Khaturia, Domar, Nilphamari. Results revealed that all clones including checks were highly susceptible to late blight except clone 235 was susceptible and the range of AUDPC values were 666.50 to 1424.00. The highest AUDPC value (1424.00) was recorded from clone 217. Clone 225 yielded the significantly highest (17.32 t ha^{-1}) which was significantly different from all others and the lowest in BARI Alu 25 (3.35 t ha^{-1}).

***In Vitro* evaluation of potato varieties against late blight disease by detached leaf methods**

A total of seven BARI released potato varieties were evaluated against late blight pathogen (*Phytophthora infestans*) under artificial inoculation condition through detached leaf method at Plant Pathology Lab., TCRC, Gazipur. Out of seven varieties, BARI Alu-25 (Asterix) was found more susceptible compared to other varieties.

Screening of different BARI released varieties against common scab disease of potato

Twelve BARI released varieties including two checks as BARI Alu-7 and BARI Alu-8 were evaluated at Tuber Crops Research Centre, BARI, Joydebpur, Gazipur during 2016-17 cropping year under the field condition at rabi season. Considering scab incidence and severity, BARI Alu-37, BARI Alu-57, BARI Alu-53, BARI Alu-56, BARI Alu-41, BARI Alu-40, BARI Alu-50 and BARI Alu-48 performed better to show lower common scab of potato.

Effect of time of lime application on the development of common scab and potato yield

An experiment having five treatments viz. 1.Liming before T. aman rice plantation, 2.Liming 30 days before potato plantation, 3.Liming 20 days before potato plantation 4. Liming 10 days before potato plantation 5. No liming or control was conducted at farmer's field, Domar, Nilphamarito know the effect of liming on the development of common scab and yield of potato and also to find out suitable timing for effective use of lime. The year of study was 2015-16 and 2016-17 cropping years and popular but susceptible Diamant potato variety was used. Use of lime significantly influenced common scab and slightly increased potato yield. The trend of disease incidence and severity was decreasing as the gap between liming and time of potato planting is increasing. The significantly highest disease incidence (45.98% and 62.09%) and severity (16.82 and 22.75) was recorded from liming 10 days before potato plantation treatment in 2015-16 and 2016-17 cropping year respectively. The highest tuber yield like 36.97 t ha^{-1} (2015-16 cropping year) and 31.15 t ha^{-1} (2016-17 cropping year) was harvested from liming before rice cultivation treatment and the lowest 33.21 t ha^{-1} and 28.12 t ha^{-1} in 2015-16 and 2016-17 respectively, was from without liming treatment.

***In Vitro* control of bacterial wilt causing Pathogen *Ralstonia solanacearum* using different chemicals**

An in vitro experiment was conducted to identify the effective chemicals against *Ralstonia solanacearum* at Plant Pathology Laboratory of Tuber Crops Research Centre, BARI, Gazipur during 2016-17. Ten *Ralstonia* isolates were collected and isolated from Seerpur, Jamalpur and Tangail. Among the isolates, isolate 5 was used for in vitro management study. Three different doses of Sable bleaching powder, Boric acid, Krosin, Sunvit, and Salicylic acid were tested against *Ralstonia solanacearum*. Among the tested chemicals, Boric acid (0.3%), Krosin-AG 10 SP (0.1%, 0.2% and

0.3%), Sunvit (0.2%, 0.3% and 0.4%), and Salicylic acid (0.1%, 0.2% and 0.3%) controlled *R. solanacearum* growth at *in vitro* condition. Stable bleaching powder of all dose were not able to control.

Pathogenicits of *Ralstonia solanacearum* causing brown rot of potato

An experiment on the morphological characterization of *Ralstonia solanacearum* causing brown rot of potato was conducted in the Plant Pathology laboratory, TCRC, Joydebpur, Gazipur, A total of 10 isolates of *R. solanacearum* were isolated. Pathogenicity testing was conducted on the potato plantlet. The three isolates showed positive reaction to plantlet and wilted the tested plantlets among 10 isolates.

Management of bacterial wilt disease using different chemicals at contact growers' farm of Jamalpur in collaboration with BADC

Significant effect of treatments was not found among the treatment combinations for controlling bacterial wilt of potato as because enough disease was not observed in field.

Evaluation of exotic potato varieties for PLRV and PVY resistance under the infection pressure (first progeny)

Eight exotic potato varieties were evaluated against PLRV and PVY to find out the resistant source (s) for releasing the suitable tolerant varieties at Joydebpur, Gazipur. All exotic varieties including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in this year. Both PLRV and PVY infection was found free in the tested varieties. Cereze and Harmosa performed better for their higher plant vigourity and yield. The experiment will be repeated in the next season.

Evaluation of clonal hybrids for PLRV and PVY resistance under the infection pressure first progeny

Seven clonal hybrid potato varieties were evaluated against PLRV and PVY to find out the resistant source (s) for releasing the suitable tolerant varieties at Joydebpur, Gazipur. All clonal hybrids including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in this year. Both PLRV and PVY infection was found free in all tested varieties. Clonal hybrids 12.2, 12.13 and 12.28 performed better considering higher plant vigourity and yield. The experiment will be repeated in the next season.

Evaluation of exotic potato varieties for PLRV and PVY resistance under the infection pressure (second progeny)

Eight exotic potato varieties were evaluated against PLRV and PVY to find out the resistant source (s) at Joydebpur, Gazipur. All exotic varieties including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in the cropping season of 2015-16 at Joydebpur. Data were taken on percent PLRV and PVY incidence, germination and yield. In growing on test during 2016-17, both PLRV and PVY infection was varied significantly among the tested varieties. Based on all parameters, Colombia, Carolus and Alouette performed better in this year. The experiment will be repeated in the next season.

Evaluation of exotic potato varieties for PLRV and PVY resistance under the infection pressure (third progeny)

Thirteen exotic potato varieties were evaluated against PLRV and PVY to find out resistant source (s) at Joydebpur, Gazipur. All exotic varieties including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in the cropping season of 2014-15 at Joydebpur. Data were recorded on percent germination, PLRV, PVY, Yield and plant vigour. In subsequent growing up test during 2016-17 as the third generation, both PLRV and PVY infection was varied significantly among the tested varieties. Based on all parameter, only one variety namely Canberra was found to be better for showing free to very lower infection PLRV and PVY.

Insect Management

Survey, documentation and risk assessments of potato wireworms at potato growing area

A field survey was conducted to document and risk assessment of potato wireworms at different potato growing area during 2016-17. Among three locations, soil sampling of Gazipur showed 1.00 wireworm larvae per sample but white grub and mole cricket were found 5.25 and 4.12 respectively. In case of bait trap at Gazipur, 2.01 larvae per trap were found. There were also percent of damage tuber by number and weight was 1.29 and 2.16, respectively. On other hand, there were no wireworm larvae found at Munshigonj and Joypurhat.

Survey, documentation and risk assessments of common cutworm complex at potato growing area

A field survey was conducted to document and risk assessment of potato common cutworms at different potato growing area during 2016-17. Among three locations, soil sampling of Gazipur showed 3.20 larvae and 2.54 pupae per sample but white grub and mole cricket were found 3.50 and 2.56, respectively. On other hand, there were no common cutworm larvae found per soil sample at Munshigonj and Joypurhat. In case of pheromone trap, average number of common cutworm moth captured/trap/week was recorded as 38.25, 45.01 and 25.34 at Gazipur, Munshigonj and Joypurhat, respectively. The highest percent of damage tuber by weight 3.78 was found at Munshigonj and Significant different from Joypurhat. At Gazipur and Joypurhat, percent of damage tuber by weight were 2.41 and 1.63, respectively. More or less similar statistical trend were also found in case of healthy tuber and yield.

Development of effective integrated management package of sweet potato weevil

The experiment was conducted to evaluate the effect of IPM management package in controlling sweet potato weevil during 2016-17 at Joydebpur, Gazipur. Among the treatments, the lowest percent of tuber damage by weight (4.03%) and maximum yield (23.68t/h) was found in pheromone + Earthing-up three times + Carbofuran 5G (T_5) treated plots which differed statistically from other treatments. In case of the lowest mean grade crown and tuber damage recorded in pheromone + Earthing-up three times + Carbofuran 5G (T_5) treated plots. Weevil infestation in relation to tuber size and maturity studied revealed that the infestation starts from the initiation of tuberisation in the control. Infestation were more in mature big tubers indicate the weevil incidence start vary early in the control plot. The weevil catch was significantly and positively correlated with weekly average r temperatures and rainfall respectively. Based on all parameters, treatment T_5 (Pheromone trap + Earthing up three times + Carbofuran 5G) showed best result in controlling sweet potato weevil throughout the crop season eco-friendly, effectively and economically.

Monitoring, documentation and damage severity of insect pests along with their natural enemies of minor tuber crops

A field study was conducted to monitoring the present status of insect pest and natural enemy of different minor tuber crops during 2016-17 at different locations. Mealy bug and aphid were observed at Gazipur, Tangail and Khagrachhari locations of cassava and percent of mealy bug infestation (18.05, 12.66 and 7.50%) and percent of aphid infestation (14.67, 15.72 and 5.35%) were found at Gazipur, Tangail and Khagrachhari, respectively. On the other hand, natural enemy of cassava such as black ant and lady bird beetle were found at these three locations. Jicama (Yam bean) insect pests and their natural enemies were observed at Gazipur and Jessore locations. In case of harmful insect, pod borer was observed and its percent of infestation was found 5.19% and 3.50% at Gazipur and Jessore, respectively. Red mite was observed only at Gazipur as a major pest status and percent of infestation found in 7.55%. Eppilacna beetle and cutworm were found 3.22/plant and 1.05/plant in Jessore and their percent of infestation were 1.89 and 4.07%, respectively. Moreover, cutworm was also found only in Jessore and its percent of infestation was 4.07% in tuber. On the other hand, natural enemy per plant such as black ant and lady bird beetle were found at Gazipur and Jessore. There was no harmful insect and natural enemy found at Jessore and Gazipur locations both for yam and Elephant foot yam.

Biotechnological Approach

Production, distribution and *in vitro* maintenance of potato varieties/germplasm

In vitro plantlets of potato were produced from virus free potato tubers of different potato varieties and genotypes using MS media under aseptic conditions during 2016-17. Several subcultures were done through node cuttings for plantlets production and short term conservation. A total of 11776 and 8290 disease free plantlets of BARI released potato varieties and CIP genotypes, respectively were sent to Breeder seed production centre, Debigonj for G_1 generation development. Moreover, 121.70 kg virus free mini tubers of BARI released varieties; 5.4 kg CIP genotypes were used for breeder seed production. As a routine work, 112.2 kg breeder seed of BARI released potato varieties were sent from TCRC, BARI to BSPC, Debigonj for production of pure seed. A total of 24 CIP clones having 581 plantlets and 21 BARI released potato varieties having 620 disease free plantlets have been maintained at Tissue Culture Lab of TCRC, BARI as mother stock.

Production of minituber (G_1) from *in vitro* plantlets at net house and green house conditions

Mini tuber production of potato has been done from virus free *in vitro* plantlets of potato at net house of TCRC, BARI during 2016-17. Number of minituber per plant 21.2, 16.0, 18.6, 9.0, 19.4, 30.4, 58.0, 37.4, 39.2, 52.4 and 15.6 was recorded from the varieties BARI Alu-7, BARI Alu-53, BARI Alu-37, BARI Alu-50, BARI Alu-62, BARI Alu-40, BARI Alu-63, BARI Alu-35, BARI Alu-41, BARI Alu-46 and BARI Alu-47 respectively. The maximum weight of mini tuber per plant was found from the variety BARI Alu-46 (358.0g) followed by BARI Alu-7 (306g), BARI Alu-63 (282.4g), BARI Alu-62 (256.6g), BARI Alu-41 (234.6), BARI Alu-53 (194.2g), BARI Alu-40 (182.4g), BARI Alu-35(142g), BARI Alu-37 (113.4g), BARI Alu-47 (42.4g) and BARI Alu-50 (24.2g). In green house condition total 16.9 kg tuber was produced from six varieties namely BARI Alu-35, BARI Alu-37, BARI Alu-40, BARI Alu-46, 426R and CIP-246.

Micro propagation of abiotic stress tolerant high yielding CIP potato genotypes and their *in vitro* bioassay for salinity tolerance

In vitro bioassay of eight potato genotypes namely CIP102, CIP106, CIP111, CIP 117, CIP124, CIP127, CIP 136 and CIP 139 have been studied for salinity tolerance at Tissue Culture Lab, Tuber Crops Research Center (TCRC), Bangladesh Agricultural Research Institute (BARI), Gazipur-1701. Single node and root tip segment of these genotypes were cultured in MS media supplemented with 0.0, 80, 100, 120, 140 and 160 mM NaCl. CIP 139 was found most salt tolerant with the highest plant height (9.67 cm), nodes number (10.50), leaves number (16.33), roots number (8.00), root length (6.50 cm), fresh weight of shoot (614 mg) and root (295.60 mg) at 160 mM NaCl (14.61 dSm^{-1}). CIP 127, CIP 102 and CIP 124 genotypes showed very good performance up to 140 mM NaCl (12.78 dSm^{-1}). Comparing to others, CIP 106 showed minimum salinity tolerance up to120 mM NaCl (10.96 dSm^{-1}) with minimum plant height (7.17 cm), nodes number (6.50), leaves number (12.50), roots number (9.7), root length (7.50 cm), fresh weight of shoot (572 mg) and root (250 mg) followed by CIP 136, CIP 117 and CIP 111 at same salinity level. *In vitro* root bioassay also revealed the salinity tolerance of CIP 139 up to 160 mM NaCl, CIP 127 and CIP 102 up to 140 mM NaCl. Among the 0.0, 0.1, 0.5, 1.0 and 1.5 mg /L IBA concentrations 0.5 mg/ L was found best for rooting with highest root number (18.76). Interestingly there was no significant difference between 0.5 and 1.0 mg/L IBA for *in vitro* root induction and development in the experimented CIP potato genotypes.

Improvement of indigenous promising potato cultivars through meristem culture and their yield performance study with traditional cultivars

Meristem culture has become a powerful and successful tool for virus elimination from infected plants and has been successfully applied in potato. A total of twenty meristem was isolated and cultured from five indigenous varieties namely Shilbilati, Lalpakhri, Sadaguti, Jam alu and patnai on basal MS media. Out of twenty meristem, seven were sub-cultured in MS media supplemented with 0 .1mg/l NAA.

Fingerprinting of popular cultivated IPVS potato and BARI released cloned potato varieties using SSR/SNP marker

Twenty one indigenous potato cultivars (IPVs) of Bangladesh and 13 BARI released clone potato varieties have been selected for fingerprinting. This experiment has been executing jointly at Molecular biology lab, TCRC, BARI, Gazipur and Michigan State University, USA. During 2016-17 21 IPVs from different locations have been collected and genomic DNA has been isolated. The genotypes have been characterized by polymerase chain reaction using SNP primers for fingerprinting. In the dendrogram with the 21 samples there are clear duplications. Primarily, we are thinking that of the 21 samples are really only from 7 different varieties having some clones have different names in different parts of the country. Secondly, in the large dendrogram 20 of the 21 clones cluster away from the US materials. This indicates a South American origin of these lines. Only one clusters with the US/European germplasms. This result is not yet been finalized. Moreover, DNA of 13 different clone potato varieties has been isolated and quality & quantity has been tested for future analysis. This is ongoing program.

Development of 3-R Gene GM potato variety for late blight resistant through *Agrobacterium*-mediated Gene delivery system

This is a collaborative research program with Michigan State University, USA and TCRC, BARI for development of 3-R gene GM potato variety against late blight disease. 3-R genes viz. RB (*Rpi-blb1*) and *Rpi-blb2* from *Solanum bulbocastanum* and *Rpi-vnt1.1* have been isolated from *Solanum venturii*, prepared pCIP99 plasmid vector along with *nptII* selectable marker gene. Twenty four events have been developed at MSU, USA in Diamant variety through *Agrobacterium* mediated gene delivery system. These events are being under trial for broad spectrum efficacy test against late blight disease. Superior 05 events will be imported in Bangladesh for commercialization after gene expression, contained and confined field trial which will resist the most devastating late blight disease in adverse conditions.

Production of nucleus seed potato (Minituber, G_1) using *in vitro* plantlet

Nucleus seed production under net house protection have been done at Breeder Seed Production Centre, Debigonj, Panchagar during the period November 2016 to February 2017 to produce high quality seed from in vitro plantlet. A total of 2774 kg minitubers were produced from 33825 plantlets. The highest amount was contributed by the variety Cardinal 936 kg.

Post- harvest Technology

Storage

Storage behaviour of potato varieties and hybrid clones under natural condition

Experiments were conducted during March to August 2016. Tubers of exotic potato varieties and clonal hybrids of RYT, AYT, SYT and PYT were evaluated for storage behavior under natural condition. In case of exotic varieties of RYT, Barcelona, Caruso, Tomensa and YP-04-80 performed better while both the CIP clones of CIP 112 and CIP 126 of RYT showed better storage performance. Regarding AYT, the clonal hybrids of 10.245 and 10.58 showed good storage performance. In exotic varieties of AYT, Yukon Gem and Camel showed better performance. Regarding secondary yield trial (SYT), the exotic varieties of Memphis, Rosi and Granada showed good performance with the clonal hybrids of 11.50, 11.68 and 11.95. In case of PYT exotic varieties of Alouette, Colomba and Heraclene showed better storage performance.

Storage behaviour of potato varieties included regional yield trial (RYT) of exotic varieties

Five exotic varieties of RYT namely Montecarlo, Barcelona, YP-04-80, Caruso, Tomensa and Granola as check were evaluated in this experiment. At 150 DAS, the minimum weight loss (26.81%) was recorded in Tomensa followed by Caruso. However, the maximum weight was (41.06%) was observed in the Check, Granola. Tomensa was not affected by bacterial soft rot up to 90 days after storage (DAS). At 150 DAS, the minimum percentage of bacterial soft rot (10.86%) was observed in Montecarlo whereas it was maximum (55.31%) in YP-04-80. on the contrary, no Fusarium dry rot (FDR) was observed in Barcelona up to 150 DAS. At 120 DAS, the maximum FDR (11.07%) was recorded in Caruso. At 150 DAS, the degree of sprouting was minimum (score 0.67) in Montecarlo followed by Tomensa (score 3.1), YP-04-80 (score 3.30) and Caruso (score 3.30), whereas it was maximum in the check Granola (3.67). Size of sprouts was minimum (score 0.67) was recorded in Montecarlo followed by Barcelona (score 2.33). Degree of shrinkage was minimum (score1.5) in Montecarlo followed by Granola (score 2.67) whereas it was maximum (score 4.33) in Tomensa. Loss of colour was observed minimum (score 3.75) in Tomensa and YP-04-80 whereas it was maximum (score 1.5) in Montecarlo. Good marketability was found in Bercelona (score 2.67) followed by Tomensa (score 1.67) whereas Montecarlo and YP-04-80 were exhibited poor marketability with the score of 1.0. The lowest weight of sprouts per tuber (0.02 g) was recorded in Barcelona.

Storage behaviour of potato varieties included regional yield trial (RYT) of CIP clones

Two CIP clones of RYT namely CIP 112 and CIP 126 were evaluated in this experiment. At 150 DAS, the minimum weight loss (25.26%) was recorded in CIP 126 followed by CIP 112 (29.28%). Both the CIP lines showed minimum bacterial soft rot percentage up to 120 DAS. At 120 DAS, the bacterial soft rot was 7.08 % in CIP 112 but it reached 78.94% at 150 DAS due to attack of potato tuber moth probably. Fusarium dry rot was minimum in both the CIP lines. It was observed that no FDR rottage was occurred after 60 DAS. CIP 126 line showed higher degree of sprouting large size of sprout and more shrinkage than CIP 112 (Table8). Tuber colour loss higher in CIP 126 and it showed poor marketability than CIP 112.

Storage behaviour of potato varieties included advanced yield trial (AYT) of exotic varieties

Three exotic varieties namely Yukon Gem,Verdi and Camel were evaluated in this experiment. At 90 DAS, the minimum weight loss (9.49%) was obtained in Camel followed by Yukon Gem (10.17%) whereas it was the highest in Verdi (12.83%). At 150 DAS, the minimum weight loss of 17.60% was recorded in Camel whereas the highest of 23.54% was observed in Yukon Gem which was statistically similar to Verdi (23.16%). At 150 DAS, the highest BSR percentage (24.08%) was observed in Yukon Gem and the lowest (18%) was recorded in Verdi. The highest FDR% at 150 DAS was recorded in Yukon Gem (5.29%) and it was lowest (1.15%) in Verdi. At 150 DAS, no sprouting was observed in Camel whereas it was maximum (score 3.17) in Yukon Gem. Large size sprout was observed in Yukon Gem with the score of 3.17. Maximum tuber shrinkage was recorded in Verdi with the score of 4.17 whereas no shrinkage was observed in Camel. Tuber colour loss was minimum in all the studied varieties with the same score of 1.67. Very good marketability was obtained in Camel with the score of 4.0.

Storage behaviour of potato varieties included advanced yield trial (AYT) of hybrid clones

Three clonal hybrids namely 10.12, 10.245 and 10.58 were evaluated in this experiment. Weight loss of tuber was statistically significant by hybrid clones. At 90 DAS, the minimum weight loss (6.24%) was obtained in the clone of 10.245 and the maximum (11.06%) in the clone of 10.58. At 150 DAS, it was followed the same pattern of weight loss of potato tubers. The minimum (14.96%) was recorded in the clone of 10.245 and the maximum (39.86%) was observed in the clone of 10.58. No bacterial soft rot was occurred in 10.245 clone up to 90 DAS. At 150 DAS, the highest percentage of bacterial soft rot (91.11%) observed in 10.58 clone and the lowest (9.01%) was recorded in 10.245. No Fusarium dry rottage was occurred in the entire studied hybrids up to 150 DAS except 10.12 and it was only 2.16% at 30 DAS in 10.12. At 150 DAS, the minimum degree of sprouting was observed in 10.12 and 10.58 with the score of 1.0. Sprout size was low in 10.12 and 10.58 with the score of 1.0. Maximum shrinkage was observed in 10.245 with the score of 2.0. The colour loss was maximum (score 4.5) in 10.58. Good marketability was observed in 10.116 with the score of 4.33.

Storage behaviour of potato varieties included secondary yield trial (SYT) of exotic varieties

Thirteen exotic varieties viz. Farida, Carversa, Navegator, Jelly,Granada, Rosi, Montreal, 7 Four 7, Taisiya, Cimega, Panamrra, Coronada andMemphis were evaluated in this experiment. At 90 DAS, the minimum weight loss (6.50%) was obtained in Memphis closely followed by Rosi (7.32%) and Granada (8.92%) whereas it was maximum (34.45%) in 7 four 7 closely followed by Montreal. At 150 DAS, the minimum weight loss of 19.65% was recorded in Granada and was maximum (55.36%) in 7 four 7. No bacterial soft rot was occurred in Taisiya up to 90 days after storage. At 150 DAS, the minimum bacterial soft rot percentage (19.60%) was observed in 7 four 7 followed by Taisiya (23.27%) and Carversa (27.81%) whereas whole the tubers were rottage (100%) in Navegator. The maximum percentage of Fusarium dry rot (74.30%) was recorded in Rosi at 150 DAS whereas it was minimum (1.88%) in Coronada. At 150 DAS, no sprouting was occurred in five exotic varieties namely Farida, Carversa, Montreal, 7 four 7 and Taisiya whereas the maximum degree of sprouting (score 3.0) was observed in Navigator. The maximum size of sprout (score 2.67) was recorded in Navigator. No shrinkage was observed in five exotic varieties namely Farida, Carversa, Montreal, 7 four 7 and Taisiya. Whereas maximum shrinkage (score 3.67) was observed in Granada. Minimum tuber colour loss was occurred in Rosi (score 4.0) and it was maximum in Panamrra Good marketability was also obtained in Rosi (4.0) whereas low marketability was observed in Panamrra whereas low marketability was observed in Panamrra with the score of 0.50.

Storage behaviour of potato varieties included secondary yield trial (SYT) of hybrid clones

Eight clonal hybrids viz. 11.50, 11.68, 11.77, 11.80, 11.93, 11.95, 11.99 and 11.105 were evaluated in this experiment. At 90 DAS, the minimum weight loss (6.25%) was recorded in 11.50 clone closely followed by 11.68 (6.67%) and 11.95 (7.90%) whereas it was maximum in 11.77 (11.66%). At 150 DAS, the minimum weight loss (10.32%) was recorded in 11.50 clone and it was maximum (26.09%) in 11.105 clone. No bacterial soft rot was occurred in two hybrid clones of 11.99 and 11.50 up to 60 DAS. At 150 DAS, the minimum bacterial soft rot (5.01%) was observed in 11.68 whereas whole the tubers were spoiled in 11.77. At 50 DAS, the minimum percentage of Fusarium dry rot (1.97%) was observed in 11.50 clone followed by 11.77 and it was maximum (60.79%) in 11.68. At 150 DAS, no sprouting was observed in 11.50 (Table 25). The minimum degree of sprouting was observed in 11.68 clone with score of 1.67 followed by 10.95 and 11.80 whereas it was maximum (score 4) in the clone of 11.105 (Table24). Large sprout was observed in 11.105 with the score 3.17 followed by 11.80, 11.93 and 11.77. Low shrinkage was observed in both of 11.68 and 11.99 with the score of 1.5 whereas it was maximum (score 4) in 11.105. The minimum tuber colour loss (score 4) was observed in 11.68. Very good marketability was observed in 11.68 with the score of 4 followed by 11.99 (score 3.5).

Storage behaviour of potato varieties included preliminary yield trial (PYT) of exotic varieties

Seven exotic varieties viz. Colomba, Alouette, Red-Valenting, Zinared, Fortus, Heraclene and Carnolous were evaluated in this experiment. At 150 DAS, the minimum weight loss (13.77%) was recorded in Alouette whereas it was maximum (40.80%) in Fortus. At 90 DAS, the minimum bacterial soft rot percentage (1.06%) was obtained in the hybrid clone of 11.68. At 150 DAS, the minimum bacterial soft rot percentage (11.73%) was recorded in Heraclene followed by Red-Valenting (21.29%) whereas the maximum rottage (60.70%) was recorded in Carnolous. No FDR (%) was occurred up to 90 DAS in all the studied varieties. At 150 DAS, the minimum percentage of Fusarium dry rot (0.48%)

was recorded in Red-Valenting followed by Carnolous whereas it was maximum (36.64%) in Fortus. At 150 DAS, no sprouting was observed in Zinared whereas Fortus showed maximum degree of sprouting with the score of 3.67. Sprout size was large in Red-Valentning, Fortus and Carnolous with the score of 3.0. The minimum shrinkage of tuber was recorded in Aloutte and Zinared with the score of 1.0. Tuber colour loss was minimum in Zinared with the score of 4.0 of whereas it was maximum in Carnolous (score 2.0). Zinared shows good marketability with the score of 4.0 whereas poor marketability was observed in Fortus (score 1.67).

Processing

Effect of different organic fertilizers on quality of potato processed products

This postharvest experiment is the continuation of the field experiment - executed at the organic block under TCRC research field, Joydebpur during the year 2016-17 to assess the influence of organic fertilizers on the yield of potato. Performance of five organic fertilizers namely Cowdung, Mega Organic Fertilizer, Vermicompost, Trichocompost and North Bengal Organic Fertilizer with two potato varieties e.g. BARI Alu-25 and BARI Alu-28 were evaluated. Mega Organic Fertilizer with BARI Alu 28 gave the better performance in case of both products i.e. chips and French fries.

Studies on the processing quality (chips and French fry) of potato cultivars and hybrid clones

Two exotic varieties of RYT were studied for their processing quality in the form of Chips and French Fries. Verdi showed better performance in both cases - chips and French fries. Seven exotic varieties under AYT were also evaluated and variety 7 Four 7 produced better quality chips while superior quality of French fries were found from Jelly in addition of 7 Four 7. Hybrid clone 11.93 out of 6 clones exhibited better performance in case of chips at AYT level whereas Hybrid clone 11.5 and 11.8 showed better only for French fries. Four CIP varieties under AYT were evaluated and CIP 239 showed better performance both in chips and French fries.

Technology Transfer

Adaptive trials with newly released potato varieties

Adaptive trials with new potato varieties were conducted at twenty two districts to promote as well as to know the farmers acceptance about the new potato varieties. All the tested varieties varied between and within location. The average highest yield over the location 29.94 t/ha was recorded in BARI Alu-41 followed BARI Alu-40 (29.62 t/ha) and BARI Alu-46 (29.62 t/ha). BARI Alu-13 (Granola) was the lowest yielder (25.09 t/ha). Framers reaction varied between the locations. All the tested varieties accepted by the farmers of different location. Their demand is timely supply of quality seed of the tested new varieties.

Promotion and dissemination of newly released climate smart potato variety at farmers' field

Adaptive trials with newly released climate smart potato varieties viz. BARI Alu-46 and BARI Alu-53 were conducted at farmers' field of five districts in northern region and BARI Alu-72 at farmers' field of five districts in saline prone area of southern region of Bangladesh. It was clear to them, LB resistance potato varieties can be cultivated without any fungicide spray or minimum spray (1-2) which reduce the cost of production and reduces the risk of LB infection and, salt tolerance variety can grow up to 10 dS/m soil salinity level which ultimately increased the productivity of potato in the country. Farmers demanded timely availability of seed potato of LB resistant and salinity tolerance potato variety for planting in next cropping season. All the tested varieties accepted by the farmers of different location. Their demand is timely supply of quality seed of the tested new varieties.

Sweet Potato

Varietal Improvement

Hybridization of sweet potato using random mating cross

A crossing program was under taken during 2016-17 at Gazipur to develop variety(s) with higher yield, dry fleshed, early bulking moderate carotene content and good taste. A total of 3450 numbers of F_1 seeds were collected from fourteen parents. Eighteen parents were included in this study. The highest number of F_1 seeds were collected from BARI SP-6 (997), followed by BARI SP-3 (710) and the lowest number of F_1 seeds produced by BARI SP-13 (1). These F_1 seeds will be sown in nursery bed next season for vine as well as tuber production and evaluation.

Observational yield trial of newly introduced polycross seeds of sweet potato

In last February, 2016 TCRC received 3290 poly cross seeds from CIP. A total of 210 healthy genotypes were developed from those seeds and these planted in a single row, from where 76 genotypes selected regarding their phenotypic characters, yield and yield contributing characters. There is a huge diversity present among these lines. Specially wide variation present in yield which varied from 55.56 t/ha to 5.56 t/ha and flesh color with white, cream, orange, deep orange with purple shade & creamy flesh with purple shade. The information has been useful for the optimal design of plant breeding programs, influencing the choice of genotypes to cross for development of new populations or for direct selection.

Preliminary yield trial on CIP clones of sweet potato

Thirty orange fleshed sweet potato (OFSP) genotypes collected from International Potato Centre (CIP) were evaluated at Gazipur and Bogra for higher yield, high dry matter %, earliness, weevil resistance and better quality. Considering these criteria, fifteen genotypes selected for the next year trial, eg. CIP 106082.1, CIP 105086.1, CIP 106526.2, CIP 106539.1, CIP 106878.1, CIP 106984.1, CIP 188002.1, CIP 189151.8, CIP 194281.2, CIP 195037.2, CIP 199062.1, CIP 420001, CIP 440004, CIP 400039 & CIP 440181.Remaining genotypes likely CIP 106469.3, CIP 106734.1, CIP 106861.3, CIP 199024.1, CIP 440181 & CIP 440328 possess extremely high dry matter content. It must be recommended for including in the main hybridization program of TCRC.

Mutation breeding of sweet potato by using gama radiation

This gama irradiation study was conducted to produce sweet potato mutants having high yield high starch and soluble sugar content, high carotene content and disease resistance. Plants form gamma-irradiated stems were grown in the field. Gama radiated plants showed early and weevil tolerant at 30gy and 50gy treated dosses. Therefore, it needs more intensified investigation and further trial.

Secondary yield trial with F_1C_4 hybrid clones of sweet potato

A field trial was conducted to evaluate eight (08) hybrid clones of sweet potato at Gazipur during 2016-17 cropping season along with BARI SP-4 and BARI SP-8 used as check. Following the selection procedure this eight (08) hybrid clones was selected from last year trial (2015-16) where 22 clones were evaluated. Among the 08 tested clones six hybrid clones namely, $H_{01.13}$/12, $H_{2.7}$/12, $H_{2.13}$/12 ,$H_{9.6}$/12 ,$H_{9.7}$/12 and $H_{9.10}$/12 were selected based on marketable yield, dry matter content, carotene content, earliness and overall acceptability score.

Secondary yield trial with F_1C_5 hybrid clones of sweet potato

A field trial was evaluated with eight (08) hybrid clones of sweet potato at Gazipur during 2016-17 cropping season along with BARI SP-4 and BARI SP-8 used as check. Following the selection procedure this eight (08) hybrid clones was selected from last year trial (2015-16) where 21 clones were evaluated. Among the 08 tested clones six hybrid clones namely, $H_{6.13}$/11, $H_{6.49}$/11, $H_{6.52}$/11,

$H_{9.13}$/11, $H_{9.40}$/11 and $H_{9.48}$/11were selected based on marketable yield, dry matter content, carotene content, earliness and overall acceptability score.

Advanced yield trail of F_1C_6 hybrid clones of sweet potato

Six clonal hybrids namely $H_{4.01}$/10, $H_{11.01}$/10,H_5.ej/10, H_8.ej/10, H_{16}.ej/10 and H_{17}.ej/10along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2016-17 cropping season at five different agro ecological environment/locations in AYT. Marketable tuber yield significantly varied in both interaction and genotype mean over location. In case of interaction effect the marketable tuber yield ranged from 12.35 t/ha ($H_{4.01}$/10 × Jessore) to 41.10 t/ha ($H_{16.ej}$/10 × Jamalpur). In case of genotype mean over location hybrid clone $H_{16.ej}$/10 yielded the highest (28.63 t/ha), followed by $H_{11.01}$/10(27.51 t/ha), BARI SP-8 (26.83 t/ha), $H_{5.ej}$/10 (25.24 t/ha), $H_{13.ej}$/10 (24.27 t/ha) and the lowest yielder was $H_{9.ej}$/10(16.46).

Considering marketable yield, dry yield, dry matter (%), carotene content, overall acceptability score and other factors four hybrid clones namely, $H_{11.01}$/10,H_5.ej/10, H_{16}.ej/10 and H_{13}.ej/10 may be selected for next year evaluation.

Regional yield trial with F_1C_7 hybrid clones of sweet potato

Three promising clonal hybrids namely $H_{9.6}$/09, $H_{16.2}$/09 and $H_{24.5}$/09 along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2016-17 cropping season at five different agro ecological environment /locations in RYT. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of sweet potato. The mean yield over locations was highest (32.45 t/ha) in $H_{9.6}$/09 followed by $H_{24.5}$/09 (26.07 t/ha) and lowest (23.05 t/ha) by $H_{16.2}$/09 genotypes. Moreover, satisfactory dry matter and weevil infestation was found in case of selected materials. Considering yield and yield contributing characters these three hybrid clones namely $H_{9.6}$/09, $H_{16.2}$/10and $H_{24.5}$/09 may be selected for next year trial for more confirmation.

Regional yield trial with F_1C_8 hybrid clones of sweet potato

Three promising clonal hybrids namely H_2/08,H_5/08, H_{47}/08 along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2016-17 cropping season at five different agro ecological environment /locations in RYT. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of sweet potato. In case of genotype mean over location hybrid clone H_{47}/08 yielded the highest (35.25 t/ha) followed by H_2/08 (32.14 t/ha) and the lowest yield H_5/08 (29.72 t/ha). All of the tested clones gave higher yield than the controls. Moreover, satisfactory dry matter and weevil infestation was found in case of selected materials. Considering yield and yield contributing characters these two hybrid clones namely H_2/08 and H_{47}/08 may be selected for proposing as variety.

Regional yield trial with CIP clones of sweet potato

Three promising CIP clone namelyCIP-441132,CIP-194513.15, CIP-440267.2 along with BARI SP-4 and BARI SP-8 used as check were evaluated during 2016-17 cropping season at five different agro ecological environment/locations in RYT. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor of different locations on the expression of different characters of sweet potato. In case of genotype mean over location the yield ranges from 30.15-37.96 t/ha and the highest (37.96 t/ha) yield obtained from CIP-440267.2 followed by CIP-441132 (35.87 t/ha) and the lowest (31.04 t/ha) by CIP 194513.15. Moreover, satisfactory dry matter and weevil infestation was found in case of selected materials. Considering yield and yield contributing characters these two CIP clones namely CIP-441132 and CIP-440267.2 may be selected for release as variety.

Performance study of BARI released sweet potato varieties

A field trial was done to evaluate thirteen (13) varieties of sweet potato at Gazipur during 2016-17 cropping season. In spite of these technologies the crops like sweet potato are being pushed to marginal areas. Considering this, we went for a fine tuning of our varietal data and tried to make it more target oriented. Among the studied varieties, BARISP-12, BARI SP-8, BARISP-13, BARISP-4 & BARISP-2 gave satisfactory yield result. But BARISP-2 is being discouraged because of its low dry matter content. BARISP-4, BARISP-12 & BARISP-13 are rich in nutrient content along with its superior yield performance.

Participatory variety selection trial with F_1C_8 hybrid clones of sweet potato

A participatory variety selection trial at farmer's field of Gazipur, Bogra, Pahartali, Jamalpur and Jessore was carried out with three hybrid clones namely H_2/08, H_5/08 , H_{47}/08 and two check variety BARI SP-4 and 8 during the winter season of 2016-17. From the mean yield of three locations the highest yield (30.33 t/ha) was obtained by H_5/08 and the lowest (22.77 t/ha) in H_2/08.

Participatory variety selection trial with CIP clones of sweet potato

A participatory variety selection trial at farmer's field of Gazipur, Bogra, Pahartali, Jamalpur and Jessore locations t was carried out with three CIP clones namely CIP 441132, CIP 194513.15 and CIP 440267.2 with two check variety BARI SP-4 and 8 during the winter season of 2015-16. From the mean yield of three locations the highest yield (31.50 t/ha) was obtained by CIP 194513.15 and the lowest (23.27 t/ha) in BARI SP-4.

Cultural Practices

Adjustment of growing season of sweet potato under climate change situation

A field experiment was conducted at two locations (Gazipur and Munshigonj) during October 2016 to April 2017 to find out the appropriate planting time and harvesting time of sweet potato. The treatment consisted of three planting time viz. 15 November 2016, 15 December 2016 and 15 January 2017 with four harvesting time viz. 90 DAP (Day after planting), 105 DAP, 120 DAP and 135 DAP. The result revealed significant variation in respect to most of the parameters. Early planting (planting time 15 November) with longer harvesting time (135 DAP) appeared the best interacting treatments to achieve maximum yield (22.37 t/ha and 44.17 t/ha) at both locations - Gazipur and Munshigonj, respectively.

Crop Nutrition

Integrated nutrient approach for yield storability and nutritional quality of sweet potato

Organic manure and chemical fertilizers were evaluated on the yield, quality component and storability of sweet potato under integrated nutrient management at Grey Terrace soil of Joydebpur and Tista Meander Floodplain soil of Bora. There were six treatments - T_1 (Control, native nutrient), T_2 (100% recommended dose of fertilizers, RDF), T_3 (Poultry manure, PM@ 3t ha^{-1}+ rest from RDF), T_4 (Cowdung, CD @ 6 t h^{-1}+ rest from RDF), T_5 (125% RDF), T_6 (Farmer's practice, FP). The yield of sweet potato was significantly ($p \leq 0.05$) influenced by the integrated use of organic manure and chemical fertilizers. The highest root yield (26.2 t ha^{-}1) was obtained in T3, where poultry manure @ 3 t ha^{-1} along with reduced rate of recommended dose of chemical fertilizers were applied. The highest marginal benefit cost ratio (MBCR) was also recorded in the same combination. At 42 DASt, sawdust and open floor showed the minimum weight loss. The treatment having more phosphate fertilizer showed the minimum weight loss. The maximum pH and nutrient availability were found in poultry manure 3 t ha^{-1}+ rest nutrient from RDF as IPNS basis. Nutritional parameters will be incorporated after receiving the analytical values. The experiment will be continued to verify the result.

Pest Management

Disease Management

Evaluation of sweet potato varieties/germplasms for resistance to virus diseases

An experiment was conducted to screen the sweet potato lines against different virus diseases in 2016-17 cropping season at Tuber Crop Research Centre, Bangladesh Agricultural Research Institute, Gazipur. Twenty four sweet potatoes germplasms were evaluated including check varieties (BARI SP-4, BARI SP-8, BARI SP-11, BARI SP-12 and BARI SP-13). In respect of lower virus infection and higher yield, H2.7/12 was found promising among the germplasms.

Biotechnological Approach

Molecular characterization of BARI released sweet potato varieties using SSR marker

This study has been conducted at Molecular Biology Lab, TCRC, BARI, Gazipur during 2016-17. Twenty three SSR primer pairs viz. IB242, IB297, IB324, IBACIP-1, IBS10, IBS11, IBR13, IBS17, IBS18, IBR21, IBC12, J175, J10, J67, J116, IB1809, IBJ544b, IBS01, IB-R16, IB-R19, IB-R03, IB-R08 and IB-S07 have been identified and collected for PCR amplifications microsatellite analysis in the present study.

***In vitro* regeneration of sweet potato (*Ipomoea batatas* L.)**

BARI SP-4 and BARI SP-8 have been used in this study for regeneration. Different conc. of Thidiazoron and BAP were used to see the direct regeneration efficiency. Significant results have not yet been generated.

Aroids

Varietal Improvement

Regional yield trial of mukhikachu (*Colocasia esculenta* var. *antiquorum*) lines

Four genotypes of Mukhikachu viz. MK 122, MK 129, MK 131, MK 176 along with a BARI released variety Bilashi as check were evaluated under regional yield trial. The growth, yield components and yield were statistically significant. The maximum average corm yield (28.48 t/ha) was recorded in MK 122 followed by MK 176 (26.03 t/ha) whereas the check Bilashi produced 25.29 t/ha.

Regional yield trial of panikachu (*Colocasia esculenta* var. *esculenta*) lines

Three genotypes of Panikachu, PK 109, PK 119, PK 134 and BARI Panikachu 1 (Latiraj) were selected as check and evaluated under regional yield trial during March to September 2016. The growth, yield components and yield were statistically significant. PK 119 line gave the highest rhizome yield of 62.84 t/ha at Joydebpur and PK 109 produced the highest stolon yield of 29.77 t/ha at Jessore among the lines and locations.

Maintenance of aroids germplasm

Twenty one Mukhikachu, fifty Panikachu and two Olkachu germplasms collected from home and abroad in recent past years. The preliminary evaluation trial is going on. The crop is now at vegetative stage.

Cultural Practices

Development of fertilizer recommendation for panikachu (C*olocasia esculenta* L.)

Organic manure and chemical fertilizers were tested at TCRC, Joydebpur and TCRSC, Bogra during January to September 2016 for sustainable aquatic taro production and to develop a suitable fertilizer package and to investigate the post-harvest properties of soil. There were six treatments - T_1 (100%

RDF), T_2 (120% RDF), T_3 (TCRC Recommended dose), T_4 (80% RDF + 3 t PM ha^{-1}), T_5 (Farmer's practice) and T_6 (Control, native nutrient). Aquatic taro (*Colocasia esculenta*) variety BARI Panikachu 1 (Latiraj) was used as a test crop. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The stolon and rhizome yields were significantly influenced by the nutrient management. The highest stolon (30.9 t ha^{-1}) and rhizome (23.5 t ha^{-1}) yields were found in T5 ($N_{100}P_{65}K_{100}$ kg ha^{-1} + CD 15 t ha^{-1}) where urea and MoP were applied in six and two splits, respectively while cowdung was incorporated in four splits. The nutrient availability was also increased in this combination. This is the second year trial and need to repeat verify the result.

Integrated nutrient management for newly released mukhikachu

Newly released Mukhikachu (BARI Mukhikachu-2) was evaluated under integrated nutrient management at Tuber Crops Research Centre, BARI, Joydebpur during 2016 to develop a suitable fertilizer package and to study the post-harvest properties of soil. There were eight treatments T_1 (Control), T_2 (100% RD), T_3 (125% RDF), T_4 (PM @3t ha^{-1}+ Rest chemical fertilizer), T_5 (CD @ 6 t ha^{-1}+ Rest chemical fertilizer), T_6 (80% RDF + 20% from PM), T7 (80% RDF + 20% from CD), T8 (Farmer's practice). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Yield of mukhikachu was significantly ($p\leq0.05$) influenced by the integrated use of organic manure and chemical fertilizers. The highest cormel (26.1 t ha^{-1}) and corm (7.00 t ha^{-1}) yields were found in 6 ton CD + rest nutrient from RDF, which was followed by 125% RDF. The post-harvest soil data will be presented after receiving the analytical report.

Effect of nutrient management on the growth and yield of newly released panikachu variety

The experiment was conducted at TCRSC, BARI, Bogra and RARS, Jamalpur during January to September 2016 to update and optimize the fertilizer package of newly released panikachu, to maximize the yield and quality and to observe the post-harvest soil properties. There were thirteen treatments - T_1 ($N_0P_{45}K_{200}$ kg ha^{-1}), T_2 ($N_{150}P_{45}K_{200}$ kg ha^{-1}), T_3 ($N_{200}P_{45}K_{200}$ kg ha^{-1}), T_4 ($N_{250}P_{45}K_{200}$ kg ha^{-1}), T_5 ($N_{300}P_{45}K_{200}$ kg ha^{-1}), T_6 ($N_{200}P_0K_{200}$ kg ha^{-1}), T_7 ($N_{200}P_{30}K_{200}$ kg ha^{-1}), T_8 ($N_{200}P_{60}K_{200}$ kg ha^{-1}), T_9 ($N_{200}P_{45}K_0$ kg ha^{-1}), T_{10} ($N_{200}P_{45}K_{150}$ kg ha^{-1}), T_{11} ($N_{200}P_{45}K_{250}$ kg ha^{-1}), T_{12} ($N_{200}P_{30}K_{150}$ kg ha^{-1} + CD 15 t ha^{-1}, Farmer's Practice), T_{13} ($N_{161}P_{36}K_{125}$ kg ha^{-1} + CD 5 t ha^{-1}, TCRC recommendation). The newly released BARI Panikachu-5 was used as test crop. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The balanced fertilizer, optimum dose and integrated nutrient management play an important role to produce rhizome and stolon of BARI Panikachu-5. The highest rhizome yield was found in T12 ($N_{200}P_{30}K_{150}$ kg ha^{-1} + CD 15 t ha^{-1}) which was closely followed by T7 ($N_{200}P_{30}K_{200}$ kgha^{-1}) at Jamalpur. The maximum stolon yield was recorded in T12 which was statistically identical to T11 at Bogra. The highest marginal rate of return was recorded in T7 followed by T12. Therefore, $N_{200}P_{30}K_{150}$ kgha^{-1} + CD 15 tha^{-1} can be recommended for sustainable Panikachu (rhizome producing) production.

Pest Management

Disease Management

Screening of new fungicides against leaf blight of panikachu

A total of eight new fungicides including the check 'Dithane M 45' were tested against leaf light of Panikachu at Joydebpur during 2015-16 at kharif season. Two fungicides namely Manfil 80 wp (Mancozeb) and Agrozeb 80 wp (Mancozeb) showed the highest reduction of diseas based on the percentage of disease incidence.

Technology Transfer

Adaptive trials with panikachu varieties at different AEZ of Bangladesh

Adaptive trials with Panikachu varieties were conducted at eight districts to disseminate as well as to know the farmers' acceptance about the varieties during 2016 crop season. On average both the stolon producing Panikachu varieties viz. BARI Panikachu 1 (Latiraj) and BARI Panikachu 2 gave similar yield. The highest stolon yield (26.57 t/ha) was recorded in Sherpur from BARI Panikachu 1. The highest rhizome yield (43.51 t/ha) was recorded in Comilla from BARI Panicakhu 5 followed by Sherpur (41.04 t/ha). Both the varieties of BARI Panikachu 4 and BARI Panikachu 5 produced statistically similar and higher rhizome yield in three districts, namely Jhenaidah, Chuadanga and Satkhira. Fermars' showed keen interest to cultivate newly released rhizome producing varieties of BARI Panikachu 4 and BARI Panikachu 5 along with stolon producing varieties of BARI Panikachu 1 and BARI Panikachu-2.

Adaptive trials with mukhikachu varieties at different AEZ of Bangladesh

Adaptive trials with Mukhikachu varieties were conducted at eight districts to disseminate as well as to know the farmers' acceptance about the varieties during 2016 crop season. BARI Mukhikachu 2 performed better at all the studied locations. Farmers' showed interest to cultivate BARI Mukhikachu 2 and demanded more supply of seed.

Minor Tuber Crops

Varietal Improvement

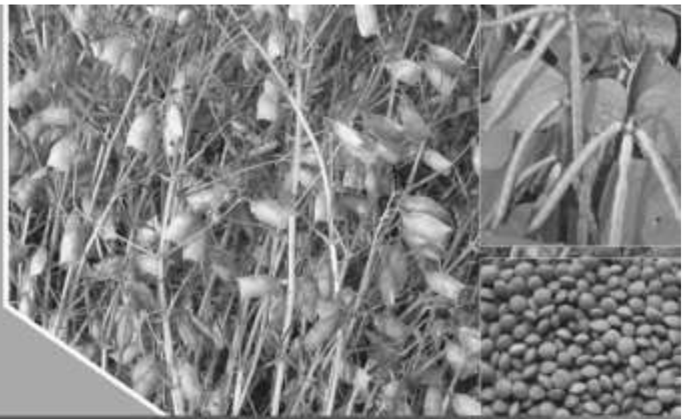
Evaluation of yam (*Dioscorea* spp.) germplasm on the basis of yield

A study of growth and yield contributing characteristics of 14 yam germplam was conducted at the research field of TCRC, BARI, Gazipur from May 2016 to March 2017. Variation was observed in respect of leaf shape, stem colour, leaf petiole petiole wing, duration, tuber shape, tuber skin colour, flesh colour, no of tuberlet/plant, length of main tuber, breath of main tuber and yield/plant. The highest yield/plant was found in YGT 07 (12.75) and the lowest was found in YGT 14 (1.08).

Collection and evaluation of cassava (*Manihot esculenta* Crantz) germplasm

A study of some morphological and tuber characteristics of two cassava genotypes (Philippine and Nagra) was conducted at the research field of TCRC, BARI, Gazipur from March 2016 to December 2016. Variation was observed in respect of plant height, stem diameter, number of leaves per plant, number of tuber per plant, diameter of tuber, length of tuber, and yield per plant. The genotype Philippine gave higher yield (3.5 kg/plant) than Nagra (2.0 kg/plant) at final harvest.

3 PULSE CROPS



Blackgram

Varietal Improvement

Generation of breeding material and advancement of generation (F_1 –F_5)

In the previous year's evaluation trail five varieties/advance lines viz. 9007, RU-139, 86337, BG-3 and BARI Mash-3 were found dwarf plant stature and bold size seed, BYMV tolerant and high yielding. These lines were utilized as parents in the crossing programme for developing new segregating materials with YMV tolerance and higher yield. Besides these, other important traits like dwarf plant type and bold seed size were also taken into consideration while designing the crossing programme. A total of 195 successful crossed seeds were collected from ten cross combinations. F_1 seeds have been stored for confirmation in the next year trail. Fifteen crosses made during 2016-17 were advanced and 57 true F_1 plants were selected. On the basis of desired characters eleven accessions were selected as confirmed cross comparing between parents. Selected plants from eleven accessions of blackgram will be grown as F_2 in the next year. Sixty eight single plants were selected from segregating generations (F_4). Seeds of each selected F_4 plants were collected and stored separately for further evaluation in the F_5 generation.

Preliminary yield trial of blackgram

The trial was carried out to determine the performance of five blackgram genotypes for yield and yield contributing characters and reaction against disease at Pulses Research Centre, Ishurdi, Pabna, PRSS Gazipur, RPRS, Madaripur and RARS, Jessore. Significant differences were observed for days to flowering, days to maturity, plant height, pod/plant, 100 seed weight, and yield. The genotype BBLX-08010-4-1 matured earlier than the other genotypes. The highest mean seed yield was recorded in BBLX-08010-4-1 followed by BBLX-08010-2-1. Three genotypes BBLX-08010-4-1, BBLX-08008-2-1 and BBLX-08010-2-1 were selected to evaluate in the next Kharif II season in RYT trial.

Participatory variety selection of blackgram

The experiment was conducted at Regional Agricultural Research Stations, Jessore, Jamalpur, Madaripur and Gazipur during *Kharif-II* season of 2016. Three Blackgram genotypes viz BBLX-06002-10, BBLX-07002-5 and 86337 with one check (BARI Mash-3) were evaluated. Considering locations the highest mean yield was found in BBLX-07002-5 (1234 kg/ha) followed by 86337 (1178 kg/ha).

Adaptive trail of blackgram genotypes in high Barind tract

The field trial was carried out at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during *Kharif-II* season 2016 to evaluate the high yielding blackgram genotypes in drought prone area. Six genotypes/varieties of blackgram *viz.* BBLX-08010-2-1, BBLX-08010-4-1, BBLX-02005-1, BBLX-07002-5, BBLX-07002-1 and BARI Mash-3 were tested in the farmer's field. Among the tested genotypes/varieties BBLX-02005-1 gave the maximum seed yield (1.39 t ha^{-1}) followed by BARI Mash-3 (1.30 t ha^{-1}) and BBLX-07002-1 gave minimum seed yield (1.17 t ha^{-1}).

Regional adaptive trials on blackgram in SAARC member countries

The most promising lines selected from previous years yield trial were grown at Pulses Research Centre, Ishurdi, Pabna during *Kharif-II* 2016 which laid out in RCB design with 3 replications with a view to select promising genotypes. Days to maturity, plant height, disease severity and yield were showed significant differences among the genotypes and rest of the traits showed non- significant among the genotypes. The entry BG-2 flowered and matured earlier than the entry BG-3 followed by BG-7 and BG- 4 matured late. Among the entries highest yield was obtained from BG- 4 followed by BG-7 and BG-2.

Nucleus seed production

Nucleus seed of blackgram varieties (BARI Mash-1, BARI Mash-2, BARI Mash-3 and BARI Mash-4) was produced and 120 single plants were selected from 1st three varieties and 60 plants selected from BARI Mash-4 for production of nucleus seed in 2017-18.

Crop nutrition

Requirement of boron on the growth and yield of blackgram

The experiment was conducted at RARS, Jamalpur during Kharif-II season of 2016 to find out optimum rates of boron for growth and yield of blackgram. The experiment was laid out in RCBD with three replications.The treatments were T_1= Control, T_2 = 20-20-20-10-2-0.5 kg NPKSZnB/ha^{-1}, T_3= 20-20-20-10-2-1.0 kgNPKSZnB/ha^{-1}, T_4=20-20-20-10-2-1.5 kg NPKSZnB/ha^{-1}, T_5=20-20-20-10-2-2.0 kg NPKSZnB/ha^{-1}, T_6=20-20-20-10-2-2.5kg NPKSZnB/ha^{-1}. Application of B on blackgram ponded positively and contributed to achieve higher yield over control treatment in different extent. Treatment T_3= 20-20-20-10-2-1.0 kg NPKSZnB/ha^{-1} and T_4= 20-20-20-10-2-1.5 kg NPKSZnB/ha^{-1} gave the highest and similar seed yield 1211 kg/ha^{-1} that was 20 % higher over control. So, it is revealed that application of 1.0 kg boron ha^{-1} with a blanket dose of 20-20-20-10-2 NPKSZn ha^{-1} was optimum for successfully blackgram cultivation in Jamalpur region.

Pest management

Screening of blackgram lines resistant to yellow mosaic virus (YMV)

The experiment was carried out at RPRS, Madaripur, PRC, Ishurdi and RARS, Jessore during *Kharif-II* season of 2016 to evaluate the germplasms of blackgram for searching of high yielding and yellow mosaic virus resistant genotypes. Significant differences were observed in every important parameters like scoring BYMV, no of pods/plant, 100 seed weight, and seed yield (kg/ha). Mean data shows that lowest BYMV score (2.89) was found in BBLXK-2004003-11 and highest score (4.89) in BBLXK-2004002-9. The line BBLXK-2004003-2, BBLXK-204001-15, BBLXK-204002-14, BBLXK-2004002-3, BBLXK-2004002-9, BBLXK-2004002-9 and BBLXK-2004003-11 selected on the basis of disease severity and higher yield.

Lentil

Varietal improvement

Generation of breeding material

Total 15 crosses involving six parents (LRIL 22-205, LRIL 21-109, DPL-62, Maitree, BARI Masur-3 and BARI Masur-6) were made to generate breeding material with high yielding, short duration, micro-nutrient enriched with stemphylium blight tolerance lentil varieties. A total of 278 successful crossed seeds were collected from seven cross combinations out of fifteen crosses. The maximum numbers of successful cross seeds 82 were found in BARI Masur-3 X BARI Masur-6 and minimum (22) collected from Maitree X BARI Masur-6 cross combinations. F_1 seeds have been stored for next year confirmation trial.

Generation advancement (F_1-F_5)

F_1s were grown from 15 crosses to generate segregating F_2 population. Thirteen F_1s were confirmed, harvested separately and will be grown in the next year. Single plant selection (SPS) were made from 14 F_2 (33 SPS), 17 F_3 (64 SPS) and 5 F_4 (82 SPS) during this year. The collected seeds from single plant were stored from the each F_1-F_4 progenies then this individual plant seeds will be grown in the next year as an individual line. In F_5 generation eleven lines were selected on the basis of yield potentiality, disease resistance and other desirable characters where all the selections were done morphologically. Each of the selected lines will be treated as family and will be grown at observation trial in the next year. Total 17 progeny bulks from different generations were selected for further evaluation in the next year.

Observation trial of lentil

Fifteen families were grown with check variety BARI Masur-6 and BARI Masur-7 in *Rabi* season of 2016-17 at Pulses Research Centre, Ishurdi, Pabna. It was observed that BLX 11014-38 was earlier than others followed by BLX 11014-17 and BLX 11014-20. The maximum pods per plant were found in BLX 11014-11 and minimum in BLX 11014-38. The highest yield was obtained from BLX 11014-11 followed by BLX 11004-8 compared to checks. Based on yield related traits eight entries, *viz.* BLX 11004-8, BLX 11011-7, BLX 11014-8, BLX 11014-10, BLX 11014-11, BLX 11018-4, BLX 11015-3 and BLX 11018-6 were selected for PYT in next year.

Preliminery yield trial of lentil (SET-I)

The experiment was carried out to determine the performance of six genotypes for yield and yield contributing characters, stability and reaction against disease that were evaluated in four different locations *viz.,* Ishurdi, Gazipur, Jessore and Madaripur during *Rabi*, 2016-17. The genotypes were BLX-1001-1, BLX-01002-12, BLX-01002-15, BLX-01002-20 and two check varieties BARI Masur-5 and BARI Masur-7. The highest number (75) of pods/plant was found in BARI Masur-7 followed by BARI Masur-5 (64) and BLX-1001-1(47). Large seed size was observed in BLX-1001-1 and BLX-1002-20 followed by BLX-01002-12 and BLX-01002-15. The highest mean yield (1170 kg/ha) was found in BARI Masur-7 and BLX-1001-1 (1140 kg/ha) followed by BARI Masur-5(1037 kg/ha) and BLX-1002-20 (981 kg/ha).The test entries BLX-1001-1 and BLX-1002-20 performed well which were selected for the next year for RYT.

Preliminery yield trial of lentil (SET-II)

The experiment was carried out to determine the performance of twelve genotypes for yield and yield contributing characters, stability and reaction against disease that were evaluated in four different locations *viz,.* Ishurdi, Gazipur, Jessore and Madaripur during *Rabi*, 2016-17. Significant differences among the genotypes were observed in case of days to flower, days to maturity, pods/plants, plant height and yield/ha. There was a significant variation also found in number of pods per plant. The highest number (53) of pods/plant was found in LRIL-18-102, BARI Masur-7 followed by BARI Masur-8 (47).The highest mean yield (1128 kg/ha) was found in LRIL-18-102 and LRIL-21-139 (1111kg/ha) followed by BARI Masur-7(1100 kg/ha)), LRIL-22-165(1100 kg/ha) and BCX-05002-6(1056 kg/ha). The test entries LRIL-18-102, BLX-05002-3, BLX-05002-6, LG-198, LRIL-22-158, LRIL-21-139 and BLX-05009-7 are performed comparatively well. These lines were selected for the next year for RYT.

Regional yield trial of lentil

The experiment was carried out to determine the performance of twelve genotypes for yield and yield contributing characters, stability and reaction against disease that were evaluated in four different locations *viz.,* Ishurdi, Gazipur and Jessore during *Rabi*, 2016-17. Significant variations was observed for days to flower, days to maturity, pods per plant, 100 seeds weight and yield in kg per hectare. The lowest days to maturity was recorded in LRIL 22-70. Large seed size was recorded in BLX 09015. Considering yield performances and GGE biplot analysis BLX 09015 and LRIL 22-70 was found better compared to others.

Screening of lentil germplasm under relay condition

Nine promising entries of lentil with BARI Masur-6 as check were evaluated at Pulses Research Centre, Ishurdi, Pabna during *Rabi* season of 2016-17 which was laid out in RCB design with 2 replications to select suitable genotypes for relay cropping with T. aman rice. Significant differences among the genotypes were observed in case of all the yield contributing characters except pods/plant. RL 12-178 was the tallest (89 cm) and BLX-06004-12 was the dwarf (32.6 cm). Bold seeded entry was identified RL 12-181 (3.22 gm) and small seeded was WB-14 (1.75 gm) on the basis of 100 seeds weight. Among the entries, the maximum yield (1681 kg/ha) was obtained from BLX-06004-2 followed by DPL-62 (1535 kg/ha) and RL 12-178 (1374 kg/ha). After considering other attributes, three entries *viz.* BLX-06004-2, DPL-62 and RL 12-178 were selected for relaying with T. aman rice.

Evaluation of early lentil germplasm under different row spacing

Four promising early entries of lentil were evaluated under three different row spacing (15 cm, 20 cm and 25 cm) at Pulses Research Centre, Ishurdi, Pabna during *Rabi* 2016-17 with a view to identify suitable row spacing for early lentil lines. Significant differences among the genotypes were observed in case of most of the yield contributing characters. LRIL 21-109 provided the maximum yield (1332 kg/ha) followed by LRIL 22-215 (1315 kg/ha). Highest yield (1376 kg/ha) was recorded from 20 cm spacing followed by 25 cm (1264 kg). In case of Genotype × Spacing interaction the maximum (1398 kg/ha) yield was recorded from V_2S_2 plot followed by V_4S_2 and V_3S_2. So, for early lines 20 cm spacing will be best fit for optimum plant accommodation as well as for higher yield.

Evaluation of lentil germplasm collected from West Bengal

Ten entries of lentil collected from West Bengal, India with two native popular varieties BARI Masur 6 and BARI Masur-7 were evaluated at Pulses Research Centre, Ishurdi, Pabna during *Rabi* 2016-17 which laid out in a RCB design with 2 replications with a view to select promising genotypes. Significant differences among the genotypes were observed in case of all the yield contributing characters except pods per plant. RL-12-179 was the tallest followed by Maitree and BARI Masur-6 was the dwarf among the tested entries. Bold seeded entry was found in BARI Masur-6 followed by RL-12-171 and small seeded entry was L-4076. Almost all the entries showed moderate resistance to stemphylium blight. Among the entries highest yield was obtained from RL-12-178 followed by RL-12-171, KLS-218 and RL-12-181. After considering other attributes, five entries *viz.* RL-12-178, RL-12-171, KLS-218, RL-12-181 and Maitree were selected for further verification.

International trials of lentil (BARI-ICARDA collaboration)

Five collaborative international trials between BARI and ICARDA were conducted at PRC, Ishurdi, Pabna during *Rabi*, 2016-17. Almost all the test entries received from ICARDA flowered very late. Most of the entries showed just vegetative growth without any pod formation. Few plants produced a small number of pods. 31 plants from four accessions of F_4, 3 families from F_5, eight accessions from international screening nursery, two (Flip- 2012-240L and Flip- 2014-094L) from micronutrient trial and 2 (Flip- 2014-029L and Flip- 2011-043L) from early trial were selected on the basis of comparative earliness and other desirable characters. All these entries will be evaluated under different trials in the next year for further evaluation.

Study the heat tolerance in lentil under field condition

Lentil is sensitive to even small increases in temperature during the reproductive stage, hence the experiment was done with a view to explore the available germplasm for heat tolerance as well as its underlying mechanisms. In the present study, a set of 10 core lentil accessions were screened for heat stress tolerance by sowing 2 months later than the recommended date of sowing. Among the genotypes, G3 showed highest number of pod/plant and yield/plant followed by G4 and G10 at late sown (LS2) under field condition.

Nucleus seed production

Total 109 kg nucleus seed of eight lentil varieties (BARI Masur-1: 03 kg, BARI Masur-2: 05 kg, BARI Masur-3:15kg, BARI Masur-4: 04 kg, BARI Masur-5: 11 kg, BARI Masur-6: 18 kg, BARI Masur-7: 13 kg and BARI Masur-8: 40 kg) was produced. Further, 960 single plant were selected in 8 BARI released varieties have also been taken for growing plant progeny rows for producing nucleus seed in the next year.

Cultural Practices

Performance of short duration lentil lines under different sowing method with different seeding rates

A field experiment was conducted at PRC, Ishurdi and PRSS, BARI, Gazipur during *rabi* season of 2015-16 & 2016-17 to find out the sowing method and optimum seed rate for short duration lentil lines for better crop growth and yield. There were two sowing methods- line sowing 20 cm apart and broadcast, and four seed rates *i.e.,*50 kg/ha, 60 kg/ha, 70 kg/ha and 80 kg/ha. It was laid out in a RCB design with three replications. It was observed that between line and broadcast sowing there was no significant difference but slightly higher yield was obtained by line sowing for both the locations. Among the seed rates 80 kg/ha produced the highest significant seed yield and the lowest was obtained by 50 kg/ha for both the locations. The combined effect of sowing method under different seed rates had no significant differences but numerically the highest seed yield was obtained by line sowing with 80 kg/ha seed rate for both the locations. The highest gross margin was recorded from 80 kg/ha seed rate under line sowing for both the locations. But the highest BCR was obtained from 70 kg/ha seed rate with line sowing for both the locations. So, the line sowing under 70-80 kg/ha seed rate is suitable for short duration genotype/line for better yield performance.

Effect of foliar application of zinc on growth and yield of lentil in rice-based system

A field experiment was conducted at Pulses Research Centre (PRC), Ishurdi, Pabna during the *rabi* season of 2016-17 to investigate the effects of foliar application of zinc on yield and yield components of lentil. There were five concentration levels of Zn (0.01 %, 0.02 %, 0.03 %, 0.04 % and 0.06%) applied as foliar which compared to control (no foliar and no soil application). Foliar applications of Zn were carried out at only one time (pre-flowering stages). The experiment was arranged in a randomized complete block design and replicated three times. Grain and straw yield, plant height, number of pods per plant, number of seeds per pod and 1000 seeds weight were measured in the experiment. There were no significant differences between the foliar application of Zn and control for any of the measured parameters of lentil in rice-based system. In order to get clear knowledge on the effects of Zn foliar application on lentil yield and its component, the experiment needs to be continued in the next year.

Effects of tillage and residue retention on the performance of lentil and mungbean in rice-based system

Performance of lentil and mungbean under three tillage treatments such as conventional tillage (CT), no-tillage (NT) and strip planting (SP) and two levels of residue retention-high residue (HR) and low residue retention (LR) were evaluated in rice-based system of Bangladesh. The field experiment was initiated in November 2015at Pulses Research Centre, Ishurdi, Pabna and Pulses Research Sub-Station, Joydebpur, Gazipur. The results of Ishurdishowed that although the adoption of NT and SP had similar effect on grain yield of lentil (Crop 1) as compared to CT but the application of SP resulted in higher number of plant population and straw yield. The greater number of branches and pod contributed to increase HI (%) in CT treatment. At Gazipur, HR increased the yield of lentil (Crop 1)in 2015-16 while the yield of lentil (Crop 1) was higher in CT than other tillage treatments in 2016-17. During the second cropping season in Ishurdi, the mungbean yields under SP and CT were comparable while lower yields were recorded from NT system than under other tillage systems. The seed yield of mungbean was higher in HR over LR at Ishurdi. However, this study will be continued for a long-term period to concrete conclusion.

Adaptation of different pulses as relay crop in the farmers' field of high barind tract

The field trial was conducted at the farmer's field of FSRD site Kadamshahar, Godagari, Rajshahi during *Rabi* 2016-17 to find out the suitability of different pulse crops as relay crop in the High BarindTract.The experiment was laid out in a randomized complete block design with three replications. There were three varieties of different pulses i.e. BARI Masur-6, BARI Motor-1, BARI *Khesari-3*. The unit plot size was 3 m x 4 m. The land was selected where T. Aman rice has been grown and the land will not be ready for *Rabi* crop in mid-November due to late harvest of rice or moisture goes down. Seeds of BARI Masur-6, BARI Motor-1 and BARI Khesari-3 @ 60, 90 and 60 kg/ha, respectively were broadcasted in the existing rice (Swarna as T. aman rice) field as relay crop on 7 November 2016. Rice was harvested retaining about 25 cm tall stubbles on 17 November 2016. Fertilizers @ 20-20-10 kg/ha of PKS were applied as basal during sowing while N @14 kg/ha was top dressed at 20 DAE. Weeding and plant protection measures against insect and diseases were taken as required. No irrigation was provided in the trial. Intercultural operations viz., weeding and insecticide spray were done in order to support normal plant growth. Lentil was harvested on 7 March 2017.Pea was harvested on 17 March 2017 and grass pea on 22 March 2017. The variable cost, gross return and gross margin were considered for choosing suitable pulse crop, because these varied widely in different crops.Among the tested pulses crop the maximum seed yield gave BARI Khesari-3 (1.12 t ha^{-1}) followed by BARI Motor-1 (0.98 t ha^{-1}). The maximum LEY was obtained from BARI Khessari-3 (0.79 t ha^{-1}) followed by BARI Motor-1 (0.69 t ha^{-1}).The BARI Masur-6 gave the lowest seed yield (0.67 t ha^{-1}). Grasspea gave the maximum gross return (TK.55300 ha^{-1}) and gross margin (Tk. 35540 ha^{-1}) followed by pea (gross return-Tk.48300 $ha^{-1}$and gross margin-Tk. 28585 ha^{-1}).The minimum gross return (Tk. 46900 ha^{-1}) and gross margin (Tk. 25610 ha^{-1}) in lentil. Total cultivation cost was the maximum in lentil crop (Tk.21290 ha^{-1}) due to schedule fungicide spraying. Cultivation cost of pea and grass pea were almost similar and they were about Tk. 19715 ha^{-1} and Tk. 19760 ha^{-1}, respectively. The BCR was higher from BARI Khesari-3 (2.69) followed by BARI Motor-1 (2.44). Among the tested crop, BARI Masur-6 (2.20) gave the lowest BCR.

Nutrient management

Response of lentil to zinc, boron and molyebdenum application

A study was conducted at the research field of Pulses Research Sub-Station, Gazipur and RARS, BARI, Jessore during 2016-17 to estimate the effective doses of micronutrients (Zn, B and Mo) for lentil yield maximization in Bangladesh. There were 8 treatments *viz.* T_1 = Control, T_2 = Zn 2.0 kg ha^{-1}, T_3= B 1.5 kg ha^{-1}, T_4= Mo 1.o kg ha^{-1}, T_5= $Zn_{2.0}B_{1.5}$, T_6= $Zn_{2.0}Mo_{1.0}$, T_7= $B_{1.5}Mo_{1.0}$ and T_8= $Zn_{2.0}B_{1.5}Mo_{1.0}$ along with the blanket dose of $N_{15}P_{20}K_{30}S_{10}$ kg ha^{-1}. The experiment was designed randomized complete block with three replications. The results showed that the seed yields of lentil ranged from 785-1081 kg ha^{-1} at Gazipur and 1292-1680 kg ha^{-1} at Jessore, respectively. The average seed yield of two locations ranged from 1093-1381 kg ha^{-1}.The highest lentil seed yield was obtained from the treatment T_8 at Gazipur and at Jessore. The lowest yield was found in control plot.The highest net return was counted from T_8 treatment at Gazipur and at Jessore. The highest benefit cost ratio 2.86 and 3.83 were counted from the treatment T_5 at Gazipur and Jessore, respectively. The lowest net return was calculated from control treatment and the lowest benefit cost ratio was also counted from the T_1 treatment at Gazipur and Jessore. Considering the benefit cost ratio the micronutrient management practices of T_5= $Zn_{2.0}B_{1.5}$ kg ha^{-1} with a blanket dose of N_{15} P_{20} K_{30} S_{10} kg

ha^{-1} may be considered as economically sound and suitable dose for lentil yield maximization in calcareeus and terrace soils of Bangladesh.

Influence of different levels of potassium on nodulation, quality, yield and nutrients uptake o lentil

An experiment was conducted in the research field of Pulses Research Sub-Station, BARI, Gazipur and RARS, Jessore during Rabi 2016-17 to estimate the suitable doses of potassium for nodulation, quality and yield maximization of lentil. There were 5 treatments *viz.* T_1 = Control, T_2 = K 30 kg ha^{-1}, T_3= K 40 kg ha^{-1}, T_4= K 50 kg ha^{-1} and T_5= K 60 kg ha^{-1} along with the blanket dose of $N_{15}P_{20}S_{10}Zn_2B_{1.5}$ kg ha^{-1}. The experiment was laid out in randomized complete block design with three replications. The results revealed that the average yields of lentil (mean of two locations) ranged from 1051-1408 kg ha^{-1}. The highest lentil yield 1168 kg ha^{-1} at Gazipur was found in T_5 and 1668 kg ha^{-1} at Jessore was obtained from the treatment T_4 and the lowest yield was found in K control plot at both the locations.The highest nodulation was found in T_5 treatment at Gazipur and T_4 treatment at Jessore. The highest net return TK. 56217 ha^{-1} and benefit cost ratio 2.51 at Gazipur was counted from the treatment $T_{5.}$ On the other hand, the greatest net return TK. 96497 ha^{-1} and benefit cost ratio 3.61at Jessore was recorded from the treatment T_4 and the lowest were in T_1 treatment in both the locations. Therefore, the appliction of 60 kg K ha^{-1} may be considered as economically sound and suitable dose for lentil yield maximization in terrace and 50 kg K ha^{-1} for calcareous soils of Bangladesh.

Integrated nutrient management on lentil

A field experiment was conducted at the Pulse Research Sub-station of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2016-17 to evaluate the effect of growth and yield of lentil with organic and inorganic nutrients and to determine the optimum rate of nutrients of lentil. Five different combination of nutrients *viz.* FRG 2012, 75% FRG + 25% CD, 50% FRG + 50 % CD, 75% FRG + 25% PM, 50% FRG + 50% PM were included in the study with one control (Native fertility). The effect of nutrient combinations on the plant growth parameters was not significant but yield characters varied significantly.The higher seed yield was produced (2016-2017) in the treatment 75% FRG +25% PM (935 kg/ha^{-1}) . Average of two years the heights seed also produced in treatment T_4 = 75% FRG +25% PM (1017 kg ha^{-1}). It may be concluded that 75% of the recommend doses of inorganic nutrient and 25% of organic sources of nutrient from poultry manure is the best treatment combination to produce lentil in the grey terrace Soil (AEZ 28) of Gazipur.

Pest Management

Screening of lentil germplasm against stemphylium blight

The screening experiment was conducted with 61 accessions based on previous year's trial for Stemphylium Blight (SB) resistance at Pulses Research Centre (PRC), Ishurdi, Pabna. These accessions were screened in natural field environments to identify resistance sources for potential use in lentil breeding. Lentil variety BARI Masur-1 (susceptible) was used as check with consistent results throughout the experiment. The highest frequency of resistance to SB was found in LRIL-22-112, ILL-5082 and ILL-6314 (0.43) and yield was produced 1718, 1518 and 1496 (kg/ha) respectively. The highest yield (2118 kg/ha) was produced by the entry LT-07. Apart from this seventeen entry were selected for disease resistance and yield performance. Upon further multilocation trial, these sources can potentially be used to develop new commercial cultivars with SB disease resistance.

Screening of lentil lines against stemphylum blight

The present screening experiment was conducted with 10 accessions based on previous trial for Stemphylium Blight (SB) resistance. These accessions were screened in natural field environments, to identify resistance at RPRS, Madaripur sources for potential use in lentil breeding. Lentil variety BARI Masur-4 (susceptible) was used as check with consistent results throughout the experiment. The highest frequency of resistance to SB was found in BLX-09001(2.2) followed by LRIL-22-70 (3.33). The highest yield (344 kg/ha) was produced by the entry LT-06 which is statistically similar to the yield (328 kg/ha) of the entries BARI Masur-4. Upon further trial, these sources can potentially be used to develop new commercial cultivars with SB disease resistance.

Efficacy of fungicides on the management of stemphylium blight in lentil

The experiment was conducted in the Pulses Research Centre, Ishurdi, Pabna, Regional Pulses Research Station, Madaripur, Regional Agriculture Research Station, Jessore and Regional Horticulture Research Station, Patuakhali during 2016-17 to find out the effective and economic fungicide in controlling stemphylium blight of lentil. Six fungicides were tested for their efficacy against the disease. All the fungicides showed significantly better performance over untreated control. Stemphylium blight disease severity ranged from 1.6-4.8 in 0 to 5 in scale. The lowest disease severity was observed in (Tebuconazole 25 %) Folicur (1.6) sprayed plot which was lower from Secure, Nativo, Rovral and Companion with highest severity (4.8) in untreated control plots. The highest yield (1066 Kg/ha) with a 73.9% increase over check was obtained from Folicur sprayed plots which was statistically similar to Nativo (1048 Kg/ha), Secure (1046 Kg/ha) and Rovral (1007 Kg/ha) sprayed plots. The lowest yield (613 Kg/ha) was recorded in untreated control plot. Economic analysis revealed that the highest Marginal Benefit Cost Ratio (MBCR 4.53) obtained from Folicur sprayed plot followed by Companion and lowest in Acrobat MZ (2.17). Considering the disease reduction and economic benefit, Folicur appeared more promising fungicide than others.

Effect of planting time and spray schedule on development of stemphylium blight of lentil

The experiment was conducted at the experimental field of Plant Pathology Division, RARS, Jessore during Rabi 2016-17 to find out optimum planting time and actual spray schedule with fungicide for controlling Stemphylium blight of lentil in a split plot design. There were four main treatments such as sowing date 25th October, 5th November, 15th November and 25th November, 2016 and four subplot treatments such as spraying at 40 DAS (Days After Sowing), 50 DAS, 60 DAS and 70 DAS. Among the treatments MP2, where planting date was 05 November 2016, and SP3, where the spray schedule started at 60DAS showed better performance for reducing disease severity and increasing yield. The highest yield (1610 kg/ha) was found in MP2 x SP3 which was statistically similar to MP2 x SP2 (1580 kg/ha) and the lowest (728 kg/ha) in MP4 x SP4 followed by MP4 x SP3.

BARI-ICARDA Collaborative program with university of Saskatchewan

Field screening of LR-59 for stemphylium blight resistance at PRC, bangladesh

The screening experiment was conducted with 48 accessions at Pulses Research Centre (PRC), Ishurdi, Pabna. Lentil variety BARI Masur-1 (susceptible) was used as checks with consistent results throughout the experiment. The higher frequency of resistance to Stemphylium Blight (SB) was found in LR 59-4, LR 59-86, Eston, LR 59-23 and LR 59-86 and produced few seeds. These sources can potentially be used to develop new commercial cultivars with SB disease resistance.

Field screening of LR-26 for stemphylium blight resistance at PRC, Bangladesh

The screening experiment was conducted with 131 accessions at Pulses Research Centre (PRC), Ishurdi, Pabna. The highest frequency of resistance to Stemphylium Blight (SB) was found in LR-26-196, LR-26-187, LR-26-275, CDC Milestone, LR-26-184, LR-26-198, LR-26-220, CDC Robin, LR-26-216, LR-26-281, LR-26-123 and LR-26-241and produced few seed. These sources can potentially be used to develop new commercial cultivars with SB disease resistance.

Chickpea

Varietal Improvement

Generation of breeding material and generation advancement (F_1, F_2 and F_5)

In hybridization program on chickpea was conducted at PRC, Ishurdi, Pabna. Total 10 fresh crosses were made to generate variability and develop new plant types. Ten crosses *viz.*, BARI Chola- 3×

BARI Chola- 5, BARI Chola- 3× ICCV 07102, BARI Chola- 3× ICCV 12115, BARI Chola- 3× ICCV 87322, BARI Chola- 5× ICCV 07102, BARI Chola- 5× ICCV 12115, BARI Chola- 5× ICCV 87322, ICCV 07102× ICCV 12115, ICCV 07102 × ICCV 87322 and ICCV 12115× ICCV 87322 made using diverse parents to develop high yielding and diseases resistant genotypes. A total of 113 successful crossed seeds were collected from 10 cross combinations. 35 F_1 and 73 F_2, single plants were selected from each progeny and harvested separately which will be grown in F_2 and F_3 generation in the next season, respectively. From F_5 generation, a total of nine families were selected from six accessions on the basis of yield, disease resistance and other desirable characters.

Preliminary yield trial of chickpea

The experiment was carried out to evaluate the performance of five chickpea genotypes along with check BARI Chola-5 and BARI Chola-9 for yield and yield related traits in six locations during Rabi 2016-17. Considering mean data for both days to flower and maturity ICCV 060157-3 was found earlier. From the mean data across location check BARI Chola-5 gave the highest pods per plant and lowest from ICCV 060157-3. The genotype BCX 01008-4 gave the highest mean seed yield followed by BCX 01008-3 whereas the genotype BCX 01008-3 was found more stable across the locations. Considering short duration, stability parameters and higher yield, three entries BCX 01008-3, BCX 01008-4 and ICCV 060157-3 were selected to evaluate in the next Rabi season under RYT.

Regional yield trial of chickpea

The experiment was carried out to evaluate the performance of six chickpea genotypes along with check BARI Chola-5 and BARI Chola-9 for yield and yield related traits in six locations during Rabi 2016-17. Considering mean data for both days to flower and maturity ICCV 07102 was found earlier. From the mean data across location ICCV 12110 gave the highest pods per plant followed by ICCV 07102 and lowest from BCX 09010-2. The genotype ICCV 07102 gave the highest mean seed yield followed by ICCV 12110 where as the genotype BCX 09010-9 was found more stable across the locations. Considering stability parameters and higher yield, finally three entries ICCV 07102, ICCV 12110 and BCX 09010-9 are selected to evaluate in the next Rabi season under PVS trial.

Participatory variety selection of chickpea

An experiment was conducted at farmer's field at FSRD site, Kadamshahar, Godagari, Rajshahi during Rabi-2016-17 to select the lines of chickpea for releasing the chickpea variety with the direct participation of farmers. Two promising lines viz., BCX 08009-9, BCX08001-3 and two released varieties BARI Chola-5 and BARI Chola-9 were used as check in this experiment. Among these promising lines BCX 08009-9 was performed better in respect.

Nucleus seed production

Total 119 kg nucleus seed of ten released varieties was produced and 1200 single plants of 10 varieties of chickpea were selected for next year nucleus seed production.

Pest management

Screening of chickpea germplasm resistant to botrytis gray mold (BGM)

A field experiment was conducted at Pulses Research Centre, Ishurdi, Pabna, during 2016-17 to find out high yielding and Botrytis Gray Mold (BGM) disease resistant variety of chickpea. Twelve chickpea advanced entries were used for this experiment. Due to unfavourable weather condition to BGM no incidence of disease was occured in this season.The highest seed yield (2037 Kg/ha) was recorded from BCX 08001-3 followed by BCX09010-6, BCX 09010-9, ICCV 93706 and BCX 06001-11and the lowest was in ICCV 92944.

Evaluation of fungicide for controlling botrytis gray mold disease of chickpea

Fungicidal screening experiment was conducted at Regional Pulses Research Station, Madaripur during 2016-17. Four different fungicides Acrobat MZ, Indofil M-45, Bavistin DF, Secure 600WG including control were evaluated under natural condition. Results revealed that among the four fungicides Acrobat MZ treated plots showed lowest diseases score (4.33) against BGM and produced highest yield (1152) and increased of yield over control (43.31%). The highest disease score (6.33) and lowest yield (653 kg/ha) was obtained in untreated control plot.

Assessment of pod borer infestation level in chickpea in mid western region of Bangladesh

A field survey was carried out in mid western region of Bangladesh during 2016-17 to determine the chickpea pod borer infestation level. Pod borer infestation varied depending on the locations and it ranged from 2.34 to 9.07%. The lowest number of moth catching (0.67/trap/week) and accordingly the lowest pod borer infestation (2.34%) was observed in Faridpur sadar followed by Jessore sadar. The highest number of moth catching (3.17/trap/week) and accordingly the highest pod borer infestation (9.07%) was observed in Jhikargacha, Jessore and the rest other areas like Ishurdi, Pabna; Godagari, Rajshahi and Chapainawabgonj sadar received more or less similar pod infestation which was in between 6.07 to 6.90%.

Fieldpea

Varietal Improvement

Generation of breeding material and advancement (F_1, F_2 and F_5)

Hybridization of fieldpea was conducted to obtain genotypes having desired gene combinations during Rabi, 2016-17 at Pulses Research Centre, Ishurdi, Pabna. Five parents were used as half diallel fashion and a total of 461 successful crossed seeds were collected from ten cross combinations. 10 F_1s were confirmed, harvested separately which will be grown in the next year as F_2 generation for the advancement of the generation. A total of five F_2 generation with desirable characters from nine were selected for next year as F_3 generation of fieldpea trial.

Evaluation of fieldpea genotypes

Nine genotypes collected from different areas of the country with IPSA Motorshuti-3 were evaluated at Pulses Research Centre, Ishurdi, Pabna during Rabi 2016-17. Yield and yield contributing characters showed significant differences among the genotypes. The genotype IPSA Motorshuti-3 was earlier and Faridpur local was late maturing. Highest pods/plant was obtained from Jhikorgacha local and lowest was obtained from BFP 11016. Among the entries highest yield was obtained from BFP 11015 followed by Bagha Local. Finally, BFP 11015, Bagha local, Jhikorgacha local, BD 9047 and Sekim local are are selected for further evaluation.

Grasspea

Varietal Improvement

Regional yield trial of grasspea

Selected three best performed genotypes from previous year preliminary yield trail were grown along with BARI Khesari-2 and BARI Khesari-3 in Rabi, 2016-2017 at Pulses Research Centre, Ishurdi, Pabna. The experiment was laid out in a RCB design with three replications. Significant genotypic differences were detected for only days to maturity and 100 seed weight. The maximum yield obtained from SEL-1348 and minimum yield from BKX-0003-1. Finally, all the three genotypes SEL-1348, BKX-0002-4 and BKX-0003-1 were selected.

Screening of grasspea germplasm under relay condition

The field experiments were conducted at Pulses Research Centre, Ishurdi, Pabna, during Rabi season 2015-16 and 2016-17 to find out the best germplasms as well as higher yield of grasspea under relay condition. The entry Sirajgonj local flowered and matured later than others. The genotype Biol-212 produced higher pods per plant than other genotypes. Bold size seeds were obtained from Nirmal. The highest yield was obtained from BKX-0003-1 which only out yielded than the check variety. Finally. four genotypes BKX-0003-1, BKX-0008-8, Sel-1348 and Patuakhali local are selected for suitable for relay cropping.

Evaluation of grasspea germplasm at Madaripur region

An experiment was conducted at Regional Pulses Research Station (RPRS), Madaripur during Rabi 2016-17 to find out the suitable and high yielding genotypes/variety of grasspea. Ten genotypes/lines and one check BARI Kheshari-3 were evaluated in the trial. Results showed that all the characters under study were significantly different among the genotypes. The result revealed that BARI Kheshari-3 gave the highest yield (1341 kg/ha) followed by BGP 130010 (1317 kg/ha) and the lowest yield (910 kg/ha) was obtained from BGP 13009.

Cultural Practices

Effect of phosphorus and moisture level on yield and BOAA content of lathyrus

The field experiment was conducted at PRC, Ishurdi and PRSS, Gazipur during *rabi* season of 2016-2017 to find out the effect of phosphorus with moisture level on yield and BOAA content of lathyrus. There were two moisture levels like- control and Light irrigation at 20 DAE which were placed in the main-plot and and 5‘P’ levels (kg/ha) viz., Control, 10, 20, 30 and 40 were levels were placed in the sub-plot. The experiment was laid out in a slit-plot design with 3 replications. The unit plot size was 3m x 4m. Soils were collected before sowing and after harvesting for NPK analysis. The sowing date was 19 November, 20016 for both the locations. Fertilizers N and K @ 20-20 kg/ha and P as per treatment were used as basal. The variety was used Serajganj local and seed rate was 60 kg/ha. Irrigation @ 2-3 cm was done as per treatment by surface irrigation. During sowing, moisture level (0-15 cm) was 22% but at the time of irrigation it was 17%. Intercultural operations were done as and when required. The crop was harvested on 21 March, 2017 and 29 March, 2017 at Joydebpur and Ishurdi, respectively. Data on yield contributing characters were recorded from 10 randomly selected plants from each plot and seed yield (kg/ha) was recorded from whole plot at harvest. The recorded data were statistically analyzed. Besides these, seed samples of Lathyrus as per treatment have been collected for BOAA analysis which is under process. Later on it will be done through the cooperation of ICARDA.

Screening of advanced grasspea genotypes/lines in saline soil

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2016-17 to observe the performance of grasspea varieties and lines. There were 4 genotypes of grasspea (SEL-1348 (E_1), BKX-002-4 (E_2) and Sirajgonj local (E_3) where BARI Khesari-3 wasused as a check variety. Sirajgonj local gave the highest yield (1.62 t/ha) and Sel-1348 had the lowest yield (1.17 t/ha). BARI Khesari-3 and SEL-1348 were the short duration (115 days) among the studied genotypes. The lowest level (3.38 dS/m) of soil salinity was recorded at the sowing time and the highest level of salinity (10.42 dS/m) was recorded at the harvesting stage.

Performance of khesari (*Lathyrus sativus* L.) cultivars relay with t.aman rice

A field experiment was conducted at Pulses Research Centre, Ishurdi during rabi season of 2015-16 and 2016-17 to find out the performance of different cultivars on the growth and yield of Khesari under relay condition. There were four cultivars BARI Khesari-1, BARI Khesari-2, BARI Khesari-3 and Sirajgonj local. The highest seed yield (853 kg/ha) was obtained from Sirajgonj local cultivar followed by BARI Khesari-2 (548 kg/ha) and BARI Khesari-1 (573 kg/ha) during 2015-16. The lowest seed yield (350 kg/ha) was obtained from BARI Khesari-3. The highest pods/plant might be contributed to higher grain yield in Sirajgonj local cultivar. In 2016-17, the yield was higher in BARI Khesari-1 and lowest was in BINA Khesari-1 than that of other cultivars, possible due to higher plant population in BARI Khesari-1 and lower in BINA Khesari-1.

Effect of rice straw height on the yield and better adaptation of grasspea

The experiment was conducted at the Pulses Reserch Centre, Ishurdi, Pabna during 2016-17 to find out the optimum rice straw height for better growth, establishment and yield of grasspea. There were six treatments that were cutting straw height at 10 cm, 20 cm, 30 cm, 40 cm, 50 cm and farmers practice (about 15 cm) in the experiment. Results demonstrated that 40 cm rice straw height was optimum rice straw height for better growth, establishment and yield (675 kg/ha) of grass pea.

Mungbean

Varietal Improvement

Generation of breeding material and generation advancement (F_1-F_5)

Five parents were used having desired genetic combinations and a total of 513 successful crossed seeds were collected from fifteen cross combinations (BARI Mung-3 x BARI Mung-6, BARI Mung-3 x TMB-37, BARI Mung-3 x Sonali, BARI Mung-3 x Sukumer, BARI Mung-6 x TMB-37, BARI Mung-6 x Sonali, BARI Mung-6 x Sukumer, TMB 37 x Sonali, TMB 37 x Sukumer and Sonali x Sukumer). To ensure fertile crosses between the parents confirmation is much essential. Fifteen F_1s obtained from Kharif-I, 2016 were grown along with their parents at Pulses Research Centre, Ishurdi, Pabna during Kharif-I, 2017. On the basis of desired characters sixteen accessions were selected as confirmed cross comparing between two parents and were harvested separately for the next year. In mungbean× mungbean crosses, single plant selections (SPS) were made in F2 (62 SPS), F3 (122 SPS), F4 (65 SPS) generations. To advance the generation in to F_5, Fifteen families were selected from five accessions on the basis of yield, disease resistance and other desirable characters which will be grown in the next season.

Observation trial of mungbean

Twenty eight lines were grown with check variety BARI Mung-6 in *Kharif-I*, 2017 at Pulses research centre, Ishurdi, Pabna. Among the test entries significant differences were observed in all studied characters *viz.*, days to flower, days to maturity, plant height, pods per plant, 100 seed weight and yield. The lowest days to flower (31) was recorded in BMXK1-12009-15 while the highest (44) in BMXK1-12006-3. The lowest mean days to maturity (60) was recorded in BMXK1-12009-26 followed by BMXK1-12009-21 and BMXK1-12009-12. The lowest plant height (69.45cm) was recorded in BMXK1-12009-26 whereas BMXK1-12006-24 was the tallest one. Highest pods per plant (16) were found in BMXK1-12004-3 followed by BMXK1-12006-11 and the lowest (6) in BMXK1-12006-24. Bold size seeds (6.45 g) were obtained from BMXK1-12009-26 followed by BMXK1-12009-12. The highest yield (1463 kg/ha) was obtained from BARI Mung-6 followed by BMXK1-12009-26, BMXK1-12009-21 and BMXK1-12002-21and lowest yield (372 kg/ha) from BMXK1-12005-9 followed by BMXK1-12002-15. Six entries, BMXK1-12009-26, BMXK1-12009-21, BMXK1-12002-21, BMXK1-12004-3, BMXK1-12002-2 and BMXK1-12002-5 were selected for next PYT.

Preliminary yield trial of mungbean

The experiment was conducted at PRC, Ishurdi, RARS Jessore, Barisal, RPRS Madaripur and PRSS, Gazipur during *Kharif-I*, 2017 to find out desirable genotypes of Mungbean. The six Mungbean genotypes *viz.* BMXK1-10011-3, $BMXK_1$-10012-2, $BMXK_1$-1009-4, $BMXK_1$-1007-5, $BMXK_1$-1007-3 and BARI Mung 6 included in the study. Considering performance at four locations and GGE biplot analysis three genotypes $BMXK_1$-10011-3, $BMXK_1$-10012-2 and $BMXK_1$-1009-4 were selected.

Regional yield trial of mungbean

Four genotypes with one check variety BARI Mung-6 were evaluated at Pulses Research Centre, Ishurdi, Pabna; PRSS, Madaripur, RARS, Rahmatpur, RARS Jessore and Gazipur during Kharif-I, 2017.Considering mean values and GGE biplot analysis over locations among the tested entries BMXK1-09012-1, BMXK1-08011 -2 and BMXK1-09015-2 were selected for PVS in the next year.

Regional adaptive trials of mungbean in SAARC member countries

Ten entries of Mungbean collected from Bangladesh, India, Nepal and Pakistan were evaluated at Pulses Research Centre, Ishurdi, Pabna during *Kharif-I*, 2017. Significant differences among the genotypes were observed in all characters studied except pods per plant. The entry MB-03 followed by MB-07 and MB-06 flowered earlier. In case of maturity, MB-03 followed by MB-06 and MB-07 matured earlier. Highest pods per plant was obtained from MB-06 followed by MB-7 and lowest was obtained from MB-10. All the genotypes showed resistance to moderately resistance of MYMV except MB-01 was moderately susceptible to MYMV. Among the entries highest yield (1321 kg/ha) was obtained from MB-03 followed by MB-08, MB-7 and MB-06.

Genetic mapping for quantitative trait loci for maturity of mungbean (*vigna radiata* l)

Mungbean (*Vigna radiata* (L.) Wilczek) varieties with synchronous maturity is generally preferred for cultivation. In this study, quantitative trait locus (QTL) mapping in mungbean using F_2 population of 142 lines derived from a cross between KPS-I (75-80 days) and BARI Mung 6 (55-60 days) was reported. $F_{2:3}$ lines grown under field condition at Gazipur 2016 and 2017. Single marker analysis suggested at least five loci controlling maturity. Composite interval mapping consistently identified four QTLs, *qMAT1, qMAT2, qMAT3, qMAT6* and *qMAT8*, on linkage groups 1, 2, 3, 6 and 8 for both years 2016 and 2017. These QTLs accounted for 7.54 to 18.83% variation depending on different linkage group.

Screening of mungbean germplasm under NaCl salinity

An experiment was conducted to study the effect of salinity on germination, root and shoot growth and nodulation of Mungbean at four salinity levels e.g. 0, 1, 2 and 3 ds/m of NaCl concentrations. Salinity affects imbibition, germination and root elongation. Highest germination % was observed in control treatment of all the varieties. Root growth was significantly reduced with higher NaCl concentrations, and BARI Mung 6 showed better performances than other varieties. All the varieties showed similar performances at higher NaCl concentration considering yield contributing character.

Crop nutrient mangement

Response of mungbean to micronutrients application

An experiment was conducted at the field of RARS, BARI, Jessore during *Kharif-I*, 2017 to estimate the effective doses of micronutrients (Zn, B and Mo) for mungbean yield maximization in Bangladesh. There were 8 treatments *viz.* T_1 = Control, T_2 = Zn 2.0 kg ha^{-1}, T_3= B 1.5 kg ha^{-1}, T_4= Mo 1.o kg ha^{-1}, T_5= $Zn_{2.0}B_{1.5}$, T_6= $Zn_{2.0}Mo_{1.0}$, T_7= $B_{1.5}Mo_{1.0}$ and T_8= $Zn_{2.0}B_{1.5}Mo_{1.0}$ along with the blanket dose of $N_{15}P_{20}K_{30}S_{10}$ kg ha^{-1}. The experiment was designed in randomized complete block with three replications. The unit plot size was 4 m x 3 m. The results revealed that the yields of mungbean ranged from 1032-1485 kg ha^{-1}. The highest mungbean yield 1485 kg ha^{-1} was obtained from the treatment T_8 followed by T_7 treatment. The lowest yield was found in control treatment.The highest net return TK.57825 ha^{-1} was calculated from T_8 and benefit cost ratio 2.86 was counted from the treatment T_5. The lowest net return was calculated from control treatment. Therefore, the micronutrient management practices of T_5= $Zn_{2.0}B_{1.5}$ may be considered as suitable dose for mungbean yield maximization in calcareous soil of Bangladesh.

Effect of arbuscular mycorrhizal fungi and *rhizobium* on mungbean in saline soil

The study was carried out to evaluate the effect of indigenous arbuscular mycorrhizal (AM) fungi, Rhizobium and three phosphorus levels on mungbean in saline soil in the net house of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2016-2017. The experiment was designed in RCBD with 10 treatments and 4 replications. Mungbean variety BARI Mung-6 was used as a test crop. Peat based rhizobial inoculum (BARI RVr-403) was used in this experiment @ 50 g kg^{-1} seed. The population density of used inoculum was more than 10^8 cfu g^{-1} inoculant. The developed soil salinity in each treatment was 4 dSm^{-1}. Soil based AM inoculum containing about approximate 275 ± 20 spores and infected root pieces of the host plant was used pot^{-1}. There were ten treatments *viz.* T_1: Control, T_2: Arbuscular mycorrhiza (AM) + 50% P, T_3: AM + 75% P, T_4: AM + 100% P, T_5: Rhizobium + 50% P, T_6: Rhizobium + 75% P, T_7: Rhizobium + 100% P, T_8: AM + Rhizobium + 50% P, T_9: AM + Rhizobium + 75% P and T_{10}: AM + Rhizobium + 100% P. Results of the experiment revealed that highest seed yield (6.83 g pot^{-1}, 46.25% higher over control) and stover yield (15.95 g pot^{-1}, 33.03% higher over control) were found in AM + Rhizobium + 75% P treatment. The results suggested that inoculation of mungbean with AM fungi or Rhizobium, especially double inoculation, causes a considerable increase in mungbean seed yield and stover yield under saline conditions by increasing percent germination, colonization and nodulation.

Effect of arbuscular mycorrhizal inoculation on mungbean at different salinity levels

Arbuscular mycorrhizal (AM) fungi increase the tolerance of host plants to different level of salinity. A pot experiment was carried out in the net house of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur in 2016-2017 with the objectives to evaluate the potentiality of arbuscular mycorrhizal inoculation on the germination (%), growth, yield and yield contributing characters of mungbean treated with different salinity levels. The experiment was designed in factorial randomized completely block design with four replications. Five salinity treatments (0, 2, 4, 6 and 8 dSm^{-1}) possessed salinity levels as the first factor and the second factor consists of mycorrhizal and non-mycorrhizal treatments. Soil based mixed arbuscular mycorrhizal (AM) inoculum containing about approximate 275 ± 20 spores and infected root pieces of the host plant was used pot^{-1}. Mycorrhizal plants showed better performance in terms of germination (%), growth parameters, yield and yield parameters than non-mycorrhizal plants. With increasing salinity concentration, germination (%), growth parameters and yield parameters decreased significantly ($p<0.01$). It was observed that 0 dSm^{-1} + AM treatment produced the highest seed yield (7.27 g pot^{-1}) and stover yield (12.97 g pot^{-1}) of mungbean. In contrast, 8 dSm^{-1} treatment produced the lowest seed yield (2.65 g pot^{-1}) and stover yield (8.39 g pot^{-1}) of mungbean. The study clearly indicates that mycorrhizal inoculation could reduce the harmful effects of salinity to the host plants, thus increase plant survival allowing the plants growth under extreme condition.

Pest management

Screening of mungbean lines resistant to MYMV and CLS

An experiment was conducted at Regional Pulses Research Station (RPRS), Madaripur, PRC, Ishurdi and RARS, Jessore during Kharif-1, 2017 to evaluate the performance of mungbean genotypes for searching of high yielding and resistant source of Yellow Mosaic Virus (YMV) and Cercospora Leaf Spot (CLS) of mungbean. Forty one mungbean lines with a check BARI Mung-6 were evaluated in the trial. Results revealed that BMMP-201506 and BMMP-201508 gave the lowest MYMV score (2.17) where the line BD-6914 gave the highest (5.50) score. Lowest (3.78) CLS score found in the line BMMP-201506 and highest (5.11) in BD-6912. The highest yield (1633 kg/ha) obtained in BD-6941 and lowest (925 kg/ha) in BD-6915.

On station trial of mungbean

Nine selected advanced lines with a check BARI Mung-6 were evaluated in the trial. Results revealed that all the tested genotypes gave resistant reaction against yellow mosaic virus disease. Among the entries, MMLI-V12 showed lowest MYMV reaction (score 1.89) where VC-3980A-88 and BD-6921 gave highest (score 3.22). The line MMB-V01 gave the highest (1245 kg/ha) seed yield and the lowest (923 kg/ha) found in VC-3980A-88.

Effect of weeding on the incidence of flower thrips and pod borers of mungbean (*Vigna radiata* L.)

Effect of weeding on flower thrips and pod borer infestation in mungbean was studied at Pulses Research Centre, Ishurdi, Pabna during *Kharif-I*, 2017.Weeding in mungbean showed a significant effect against flower thrips and pod borer infestation. No weeding plots received less number of flower infestation by thrips than that of weeding at one or two times. On the other hand, weeding plots received less number of pod borer infestation than that of no weeding plots. So, it was seen that weeding in mungbean received lower pod borer infestation but higher flower thrips infestation and the reverse was true in case of no weeding. Weeding showed highly significant effect in yield increase of mungbean. Simply weeding in mungbean increased upto 65.26% higher yield over no weeding plots but the higher cost of weeding failed to provide remarkable benefit. The highest benefit (MBCR 1.55) obtained from no weeding with insecticide (Imitaf 20 SL @ 0.5 ml/l) spraying followed by single weeding at 12 days after sowing (MBCR 1.42).

Eco-friendly managment of flower thrips and pod borers of mungbean through sesame intercropping

Effectiveness of sesame intercropping in mungbean in managing flower thrips and pod borer of mungbean was studied at Pulses Research Centre, Ishurdi, Pabna during *Kharif-I*, 2017. Sesame intercropping reduced flower thrips and pod borer infestation in mungbean significantly. Among the intercropped treatments, mungbean : sesame at 2:2 row ratio was found the best in reducing flower thrips and pod borer infestation. Sesame intercropping showed equivalent performance in reducing pod borer infestation like insecticide spraying (Imitaf 20 SL @ 0.5 ml/l). Significantly the highest mungbean equivalent yield (1692 kg/ha) and benefit ((BCR 2.16) was obtained from the sole mungbean spraying with insecticide followed by sole mungbean without spraying. Intercropping sesame in mungbean provided lower equivalent yield and benefit than sole mungbean. This might be due to lower market price of sesame than mungbean. Among the intercropped treatments, the highest equivalent yield (1294 kg/ha) and benefit (BCR 1.84) was recorded from mungbean intercropped with sesame at 3:2 row ratios which was more or less similar to other intercropped treatments.

Cowpea

Cultural Practices

Adaptation of cowpea genotypes in southern region

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during Rabi season of 2016-17 to find out the suitable genotype(s) of cowpea for better adaptation as well as higher yield in southern region of Bangladesh. Six entries of cowpea *viz.*, E_1 = CPS-6, E_2 = CPS-12, E_3 = CPS-13, E_4 = CPS-14, E_5 = CPS-15, and E_6 = BARI Felon-1 (check variety) were tested in this experiment. Statistically significant differences were observed among the entries in terms of days to flowering, pod length, 100-seed weight and seed yield. Days to flowering was the highest (56.00 days) in CPS-6 followed by BARI Felon-1 (53.67 days). The longest pod (30.25 cm) was found in CPS-15 but CPS-6 gave the shortest pod (18.19 cm). BARI Felon-1 produced the highest weight of 100-seed (11.42 g) that was statistically identical to that of CPS-12 (11.29 g). Likewise, the highest yield of seed (1459 kg/ha) was achieved from BARI Felon-1 followed by CPS-

12 (1092 kg/ha) and CPS-13 (1026 kg/ha). Finally it can be concluded that the cowpea entries CPS-12 and CPS-13 were promising, although BARI Felon-1 gave the highest yield.

Crop nutrient management

Effect of NPKSZNB on yield and yield contributing characteristics of cowpea

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur and Barisal during two consecutive Rabi seasons of 2015-16 and 2016-17 to find out the effective dose of mineral nutrients for cowpea to achive and higher yield in southern region of Bangladesh. Five treatments were included in the study *viz.* $T_{1=}$ (Control), $T_{2=}$ (20-20-20 NPK kg ha^{-1}), $T_{3\,=}$ (20-20-20-10 NPKS kg ha^{-1}), $T_{4=}$ (20-20-20-10-2 NPKSZn kg ha^{-1}) and $T_{5=}$ (20-20-20-10-2-1.5 NPKSZnB kg ha^{-1}). The experiment was laid out in Randomized Complete Block design with three replications. The unit plot size was 4m rows×3m long. The variety was BARI Felon-1. Seeds were sown at the rate of 50 kg ha^{-1} on 8 December, 2015 and 16 December, 2016. In 2015-16 and 2016-17, Number of pod/plant, Seed/pod,Pod length, 100-seed weight and grain yield of different treatments significantly varied by the fertilizer treatment of cowpea. In both the years, the highest seed yield were observed 1570 and 1216 kg ha^{-1} from treatment T_5 (20-20-20-10-2-1.5 NPKSZnB kg ha^{-1}) during 2015-16 and 2016-17 respectively. The highest average yield was recorded 1591 kg ha^{-1}. From the aforesaid-results, it may be concluted that nutrient management practices of 20-20-20-10-2-1.5 NPKSZnB kg ha^{-1} is suitable for cowpea yield maximization in southern region of Bangladesh.

Technology transfer activities of pulses

Technology transfer activities have been done through seed production & distribution, training & block demonstrations, field days and workshops, publication of booklets, leaflets, posters, broadcasting news in radio, TV etc. during 2016-17. Pulses Research Centre produced 14,034 kg of seeds of different pulse crops and distributed 10,099 kg of seed to the farmers, BADC, research organizations universities and NGOs. A total of 20 scientists received training on R software, 1325 farmers got training on modern production technologies of pulses, 46 block demonstrations (1 acre each) of different pulse crops were established, 8 field days were organized with 670 participants and one inception workshop were organized with 100 participants at BARI, Gazipur, 1 booklets and 2 leaflets were published under "Strengthening of oilseed and pulses research and development in Bangladesh project". With the financial support of Harvest Plus (Bio-fortification) Project, 600 farmers and 40 staffs received training, 20 demonstration blocks (4 bigha each) of bio-fortified lentil were established and 5 field days were organized with 500 participants during 2016-17. Under the umbrella of IFAD project, a total of 300 farmers and 33 field staffs have been trained up before establishment of block demonstrations in 90 bighas of grasspea, 130 bigha of lentil and 80 bigha of chickpea in Madaripur and Patuakhali districts of Bangladesh in the rice-fallow cropping pattern based area. In addition, 180 women were trained up about value addition products and post harvest processing of pulse crops at Barind region. A total of 5 field days were arranged to inform the performance of improved pulse varieties specially lentil, chickpea and grasspea. Comparing the varietal performance BARI Khesari-3 was more acceptable to the farmer's of Barisal region and in Barind region it was BARI Masur-6, BARI Chola-5 and BARI Chola- 9. Extension personnel, farmers and concerned persons were very happy to receive the improved production technologies through training and they expressed their satisfaction to observe the yield performance of improved varieties of pulse crops.

Rapeseed and mustard (*Brassica* spp.)

Varietal Development

Maintenance of germplasm of *Brassica rapa*, *Brassica juncea* and *Brassica napus*

A total of 136 accessions of which 75 accessions of *Brassica rapa*, 43 of *B. junce a*and 33 of *B. napus* were sown on 18 November 2016 in order to maintain the germplasm as well as to increase seed for future breeding programme.

Development of bc_2s_3 generation in *Brassica rapa*

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-9 and Improved Tori-7 were crossed with Local Tori-7 (LT-7) during rabi 2011-12 to develop F_1. Developed six F_1s were crossed with LT-7 to develop BC_1 and BC_2 during rabi 2012-13 and 2013-14. BC_2S_2 seeds were sown on 16 November 2016 to develop BC_2S_3. Unit plot size was 3 rows 3m long. Proper netting of each cross combinations was done to protect out crossing and to encourage intra-mating among the same population.

Days to flowering and maturity of cross combinations were ranged from 20-23 days and 85-90 days, respectively. Cross combinations (BARI Sar.-15 x LT-7) x LT-7x LT-7 and {IT-7 (S_4) x LT-7} x LT-7x LT-7 were found to be earlier among the other combinations. Seeds were stored to evaluate as well as advance BC_2S_4 generation in the next year.

Development of short duration inbred lines in *Brassica rapa*

Advancing S_5 to S_6 generation

Three hundred and seventy six plants were selected from 127 rows for selfing for advancing S_5 to S_6 generation from nine source populations. Total 5603 buds were selfed from which 1954 effective siliquae and 7936 seeds were obtained. Selfed seeds were stored for maintaining as inbred lines in the next year.

Growing of F_1 generation in *Brassica rapa*

Number of selfed plants from different cross combinations ranged from 21-26 and total 186 plants were selfed. One thousand nine hundred and fifty three buds were selfed from 186 plants to develop F_2 generations. One thousand four hundred and fifty six siliquae were obtained from which five thousand four hundred and forty four seeds were obtained. Selfed seeds were stored to advance F_2 generation in the next season.

Evaluation of segregating generations of *Brassica rapa*

F_5 generation

Fifteen progenies having yellow seed coat colour from three cross combinations and five progenies having brown seed coat colour from four cross combinations were evaluated. Considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, five progenies having yellow seed coat colour were selected from fifteen progenies and five progenies having brown seed coat colour were selected. Seeds of selected plants of individual progeny were bulked and stored for evaluation in F_6 generation in the next year.

F_6 generation (Set-I)

Progenies having brown seed coat colour from four cross combinations were evaluated. Considering earliness (maturity duration upto 87 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, thirty nine desirable plants were selected from four cross combinations. Seeds of selected plants of each cross combinations were harvested separately and stored for evaluation in Observation Trial in the next year.

F_6 generation (Set-II)

Forty seven progenies having yellow seed coat colour from four cross combinations and eight progenies having brown seed coat colour from two cross combinations were evaluated. Considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, fourteen families having yellow seed coat colour were selected from forty seven families and four families having brown seed coat colour from eight families. Seeds of selected plants were bulked and stored for evaluation in the next year.

Observation trial of *Brassica rapa* (set-i)

Variations were observed among the lines for all the characters studied. Maturity duration ranged from 81-87 days. Ten lines were matured within 85 days whereas check variety BARI Sarisha-14 took 81 days. Plant height ranged from 77-95 cm. No. of siliquae/plant ranged from 23-99. The highest no. of siliquae/plant recorded in BC-214-Y-6 . No. of seeds/siliqua ranged from 13-31. The highest no. of seeds/siliqua recorded in BC-2014-Y02. Thousand seed weight ranged from 3-4 g. Seed yield ranged from 1042-1639 kg/ha. The highest seed yield recorded in BC BS-14X BS 15-1 (NET) (1639 kg/ha). Considering earliness, seed yield and other yield contributing characters, four lines BS-14X BS 15-1 (NET), BC-2014-B08, BS-14X BS 15-3 and BC-2014-Y03 (NET) were selected for the next trial.

Observation trial of *Brassica rapa* (set-ii)

Variation was observed inno. of seed/siliqua. Maturity duration ranged from 82-85 days. Nine tested lines matured at or below 85 days. Plant height ranged from 76-101 cm. The highest plant height was recorded in BS 6XSAU-1-3. No. of siliquae/plant ranged from 36-106. The highest no. of siliquae/plant was recorded in BS 6XSAU-1-1. No. of seeds/siliqua ranged from 12-33. Thousand seed weight ranged from 3-4g. Seed yield ranged from 1153-1736 kg/ha. The highest seed yield recorded in BS 100614(4)-10 (1736 kg/ha). Considering earliness, seed yield and other yield contributing characters, five lines BS 100614(4)-10, BS 6XSAU-1-1, BS 6XSAU-1-3, BS-14XBS-15-10 and BS 100614(4)-4 were selected for the next trial.

Preliminary yield trial of *Brassica rapa*(set-i)

Nineteen lines of *Brassica rapa* having yellow seed coat colouralongwith BARI Sarisha-14 and Tori-7 as checks were evaluated at Joydebpur, Ishurdi, Jessore, Rahmatpur and Hathazari for yield and yield contributing characters. Significant variations were observed for no. of siliquae/plant and no. of seed per siliquae. Maturity duration ranged from 80-89 days. Plant height ranged from 73-93 cm. The lowest plant height was recorded in BC-100614 (4) -5. No. of siliquae/plant ranged from 33-93. The highest no. of siliquae/plant was recorded in BC-110714 (7) -8. No. of seeds/siliqua ranged from 13-52. The lowest no. of seeds/siliqua was recorded in BC-110714 (7) -8. Thousand seed weight ranged from 3-4 g. The highest 1000-seed weight was recorded in BC-100614 (4) -5 which was statistically similar with other three tested lines. Seed yield ranged from 1247-1768 kg/ha. All the tested lines showed statistically identical seed yield except check variety Tori-7. Regarding maturity duration over locations, days to maturity ranged from 80-89 days. Seed yield ranged from 1247-1768 kg/ha over locations. The line BC-100614 (4) -6 produced the highest seed yield over locations and it also produced the highest seed yield at Rahmatpur and Hathazari locations.Considering earliness, seed yield and other yield atributing characters, four lines like BC-100614 (8) - 3, BC-100614 (4) -4, BC-100614 (4) -2 and BC-100614 (4) -8 were selected for RYT in the next year.

Regional yield trial of *Brassica rapa*

Eight advanced lines of *Brassica rapa* along with BARI Sarisha-14 and Tori-7 as checks were evaluated at Joydebpur, Ishurdi, Jessore, Hathazari and Rahmathpur for seed yield and yield contributing characters in order to select line(s) for development of short duration variety of rapeseed. Significant variations were observed for siliquae/plant and seeds/siliqua at Joydebpur. Maturity duration ranged from 80-81 days. Check varieties BARI Sarisha-14 and Tori-7 were matured within 80 days. Plant height ranged from 79-100 cm at Joydebpur. The lowest plant height was recorded in Tori-7 and BC-100614(3)-1. No. of siliquae/plant and no. of seeds/siliqua ranged from 31-62 and 14-30, respectively. The highest no. of siliquae/plant was recorded in BS 15YF-01. The highest no. of seeds/siliqua was recorded in BC-100614(4)-9 which was statistically similar with BARI Sarisha-14. The lowest no. of seed/siliqua was recorded in Tori-7. Thousand seed weight ranged from 3-4 g. Seed yield ranged from 1308-1762 kg/ha. The highest seed yield was recorded in BC-100614(4)-7. The lowest seed yield was recorded in check Tori-7. Regarding maturity duration over locations, days to maturity ranged from 80-81 days (Table 11a). Check variety BARI Sarisha-14 and Tori-7 were the earliest in maturity along with BC-100614(1)-6 (80 days, respectively) over locations. Seed yield ranged from 1308-1762 kg/ha over locations. The line BC-BC-100614(4)-7 produced the highest seed yield over locations and it also produced the highest seed yield at Joydebpur and Jessore locations. Check variety Tori-7 produced the lowest seed yield over locations. Considering earliness, seed yield and other yield attributing characters, three lines like BC-100614(4)-7, BC-100614(8)-4 and BC-100614(4)-9 were selected for Adaptive Trial in the next year.

Evaluation of segregating generation of *Brassica juncea,* F_6 generation (Set-I)

Single plant selection method was followed. A total of 114 plants from fifteen cross combinations having brown seed coat colour and 21 plants from two cross combinations having yellow seed coat colour were selected considering erect and compact plant type, seed colour, seed size and siliqua shape. Four cross combinations were discarded. Seeds from selected plants of individual cross combinations were harvested in bulk. Seeds were stored for evaluation in Observation Trial in the next year.

F_6 generation (Set-II)

A total of seventy nine progenies from three cross combinations having black/brown seed coat colour were evaluated and twenty seven progenies were selected. Twenty seven progenies from three cross combinations having yellow seed coat colour were evaluated and twelve progenies were selected. Considering erect and compact plant type, seed colour, seed size and siliqua shape, single plant selection method was followed. Harvested seeds from selected plants of individual progeny were bulked. Seeds were stored for evaluation in the next year.

Observation trial of *Brassica juncea*

Maturity duration ranged from 102-106 days. Maturity duration ranged from 102-106 days. BJ 2014-Y04 and BJ 2014-B16 were the earliest in maturity (102 days). Plant height ranged from 116-145 cm. The line BARI Sarisha -11 (ch) showed lowest plant height (130.4). No. of siliquae/plant ranged from 87-174. No. of seeds/siliqua ranged from 11-13. Thousand seed weight ranged from 3-4 g. Seed yield ranged from 1404-2126 kg/ha. The highest seed yield recorded in BJ 2014-B10 and followed by BJ 2014-B11. Considering earliness, seed yield and other yield contributing characters, four lines BJ 2014-B10, BJ 2014-B11, BJ 2014-B17 and BJ 2014-B1605 were selected for the next trial.

Preliminary yield trial of *Brassica juncea* L.

Eleven genotypes of *Brassica juncea* including BARI Sarisha-11 and Sarisha-16 as checks were evaluated at Joydebpur, Ishurdi, Jessore and Hathazari for yield and yield contributing characters. All the characters studied showed significance except days to maturity and plant height. Days to maturity ranged from 103-104 days. Plant height ranged from 113-133 cm. No. of siliquae/plant ranged from 103-174. No. of seeds/siliqua ranged from 11-13. The highest no. of seeds/siliqua was recorded in BJ 11536 (9)-2 and BJ 11536 (12)-3. Thousand seed weight ranged from 3-4 g. Seed yield ranged from 1432-2121 kg/ha. The highest seed yield was recorded in BJ 2014 - Y 02. Regarding maturity duration over locations, days to maturity ranged from 103-104 days. Seed yield ranged from 1656-2161kg/ha over locations. The highest seed yield was recorded in BARI Sarisha -16 (ch) over locations. Consudering seed yield and other yield contributing characters, four lines like BJ 2014 - Y 05, BJ 2014- Y 01, BJ 2014 - Y 03 and BJ 2014 - Y 02 were selected for evaluation in RYT.

Regional yield trial of *Brassica juncea* L.

Nine advanced lines of *Brassica juncea* along with BARI Sarisha-11 as check were evaluated at Joydebpur, Ishurdi, Jessore, Hathazari and Rahmatpur for seed yield and yield contributing characters. Significant variation was observed for all the characters studied except plant height and no. of siliquae/plant. Maturity duration ranged from 103-104 days. Plant height ranged from 102-132 cm. No. of siliquae/plant ranged from 102-196. The highest no. of siliquae/plant was recorded in BJ 53611 (12)-8. No. of seeds/siliqua ranged from 11-13. The highest no. of seeds/siliqua was recorded in BJ 53611 (12)-8. Thousand seed weight ranged from 2-3 g. Seed yield ranged from 1449-1956 kg/ha. BJ 11536 (12)-6 produced the highest seed yield (1956 kg/ha) followed by BJ 1111 (7)-7 (1888 kg/ha).Regarding maturity duration over locations, days to maturity ranged from 102-104 days. Seed yield ranged from 1660-2188 kg/ha over locations. The line BJ 1111 (7)-7 produced the highest seed yield (2188 kg/ha) followed by BJ 53611 (12)-8 (2123kg/ha) over locations. Considering location wise seed yield and other yield contributing characters, three lines BJ 1111 (7)-7, BJ 53611 (12)-8 and BJ 1110 (12)-1 were selected for Adaptive Trial in the next year.

Maintenance of CMS, maintainer and restorer lines of *Brassica napus*

Days to flowering and maturity for CMS lines ranged from 23-25 days and 106-107 days, respectively. In total 623 buds of 49 plants of two CMS lines were crossed with two maintainer lines. One thousand nine hundred and twenty nine seeds were obtained from 410 siliquae. Seeds were stored for future breeding programme. Days to flowering and maturity for Nap-248M and Nap-279M were 24-26 days and 102-103 days, respectively. Flowering and maturity duration for Nap-14-01R were 31 and 122 days, respectively. One thousand four hundred and senenty four buds were selfed from 113 plants. In total 4178 seeds were obtained from 1062 siliquae. Seeds were stored for future breeding programme.

Development of hybrid variety in rapeseed

Identification of parental lines in *Brassica rapa* L.

All of the plants in S_3 population of hybrid ‘Golden Sapphire’ were identified as pollen fertile plants. Results on selfing of pollen fertile plants in S_3 population of hybrid ‘Golden Sapphire’ are presented here. Flowering ranged from 20-22 days and maturity ranged from 90-92 days. Six hundred and eighty five buds were selfed from 83 plants. In total 405 siliquae were obtained from which 4627 seeds were obtained. Seeds were stored for advancing S_4 generation in the next year.

Identification of parental lines in *Brassica napus* L.

Almost all of the plants in S3 population of hybrids ‘Yunyouzaerhao-2’ and ‘Yunyouzaerhae-10’ were identified as pollen fertile plants. Results on selfing of pollen fertile plants in S3 population of hybrids ‘Yunyouzaerhao-2’ and ‘Yunyouzaerhae-10’ are presented in the description. Days to flowering and maturity ranged from 22-23 days and 108-110 days, respectively for Yunyouzaerhao-2 and days to flowering and maturity ranged from 21-23 days and 110-113 days, respectively for Yunyouzaerhae-10. Two thousand four hundred and eighty buds were selfed from 89 plants. In total 888 siliquae were obtained from which 8524 seeds were obtained. Seeds were stored for advancing S4 generation.Results on crossing between CMS plants and selected pollen fertile plants (male parent) of hybrids 'Yunyouzaerhao-2' and 'Yunyouzaerhae-10' are presented here. Seventeen CMS plants in Yunyouzaerhao-2 were crossed with pollen fertile plants (male parent) and 74 siliquae obtained from which 585 seeds were obtained. Eighteen pollen fertile plants (male parent) in Yunyouzaerhao-2 were selfed and 124 siliquae obtained from which 1247 seeds were obtained. In case of Yunyouzaerhae-10, Ten CMS plants were crossed with pollen fertile plants (male parent) and 55 siliquae obtained from which 655 seeds were obtained. Nine pollen fertile plants (male parent) in Yunyouzaerhao-10 were selfed and 66 siliquae obtained from which 610 seeds were obtained. Seeds were stored for growing in the next year.

Evaluation of test cross hybrids in *Brassica napus* L.

Results on test crosses between $CMSZ_1$ (248) x Nap-2014-01R, $CMSY_2$ x Nap-2014-01R and $CMSY_{10}$ x Nap-2014-01R are presented here. Days to flower and maturity for test crosses ranged from 22-23 days and 97-112 days, respectively. Pollen fertile plants ranged from 95-100% and CMS plants ranged from 0-5%. Hybrid seeds of those four hybrids were produced for large plot evaluation in the next year.

Maintenance of parental lines of selected test cross hybrids in *Brassica napus* L.

Results on selfing of selected plants of restorer lines of test crosses [$CMSZ_1$ (248) x Nap-2014-01R] are presented here. Days to flower and maturity of selected plants of restorer line ranged from 24-25 days and 118-120 days, respectively. Four to nine plants were selfed from each line and 42-96 buds were selfed from these lines from which 111-386 seeds were obtained. Selfed seeds of selected plants were stored for maintenance in the next year. Results on selfing of selected plants of restorer line of test crosses ($CMSY_2$ x Nap-2014-01R) and ($CMSY_{10}$ x Nap-2014-01R) are presented here. Days to flower and maturity of selected plants of restorer line ranged from 23-25 days and 118-120 days, respectively. Five to eight plants were selfed from each line and 52- buds were selfed from these lines from which 164- 387 seeds were obtained. Selfed seeds of selected plants were stored for maintenance in the next year.

Development of short duration parental lines

***Brassica napus* L.**

Results on crossing between CMS lines and short duration *Brassica napus* lines/varieties are presented here. Days to maturity for CMS lines ranged from 97-99 days and for *Brassica napus* lines/varieties ranged from 87-95 days. One thousand four hundred and ninety two buds of 91 CMS plants were crossed with short duration *Brassica napus* lines/varieties. Seven hundred and eighteen siliquae was obtained from which 2966 seeds were obtained. Seeds were stored for back crossing in the next year.Results on crossing between restorer line and *Brassica napus* varieties/lines are presented here. Days to maturity for restorer line was 117-119 days and for *Brassica napus* varieties/lines ranged from 93-95 days. Seven hundred and eighty eight buds of 44 restorer plants were crossed with short duration *Brassica napus* varieties/lines. Four hundred and twenty two siliquae was obtained from which 1867 seeds were obtained. Seeds were stored for back crossing in the next year.

Regional yield trial of double low genotypes of *Brassica napus* L.

Variations were observed among the genotypes for all the characters studied except no. of seeds/siliquae and seed yield. Maturity duration ranged from 92-96 days. Genotypes Nap -14004 and Nap-14010 were the latest (96 days) in maturity. Plant height ranged from 86-132 cm. Check variety BARI Sarisha-14 showed the lowest plant height (86 cm). No. of siliquae/plant ranged from 47-110. No. of seeds/siliqua ranged from 20-42. The highest no. of seeds/siliqua recorded in Nap-14010. Thousand seed weight ranged from 3-4g. Seed yield ranged from 1575-2000kg/ha. The highest seed yield was recorded in Nap-14007 (2000 kg/ha) and lowest in check variety BARI Sarisha -14 (ch).Oleic acid (ω -9) ranged from 20.21 to 62.39%. The highest oleic acid recorded in BN-14007 and lowest in BARI Sarisha-13. Linoleic acid (ω-6) ranged from 17.82 to 25.25.81%. Linolenic acid (ω-3) ranged from 7.89 to 11.83%. Genotype BN-10401showed the highest linolenic acid and BN-14007 showed the lowest. Erucic acid ranged from 0.08 to 35.33%. The highest erucic acid was recorded in BARI Sarisha-13 (35.33%). The tested genotypes showed erucic acid ranged from 0.08 to 2.86%. Glucosinolate of tested genotypes ranged from 8.705 to 15.560 (µmol/g DW).Considering seed yield and other yield contributing characters, low erucic acid (less than 2%) and other essential fatty acids, and low glucosinolate (less than 30 µmol/g), genotypes Nap-14007 and Nap-14011 were selected as promising 'double low' (Banola) lines.

Crop Management

Effect of different type of mustard variety in mustard- boro mixed cropping system

A field experiment was conducted at MLT site, Debidwer, Comilla and Hatila, Chandpur during rabi season of 2016-17 to find out the suitable mustard variety in Mustard- Boro mixed cropping system and to calculate the cost and return of mixed cropping system in Comilla region. The experiment laid out in RCB design with 5 dispersed replications. Four different treatments i.e T_1= 100 % boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-9, T_2 = 100 % boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-14, T_3 = 100 % boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-15, T_4 = 100 % boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-17and T_5 = Farmers practice (Var. Sole BRRI dhan29 and Tori-7) were used in the experiment. From the evidence of research it was observed that the highest rice equivalent yield (9.55 t ha^{-1}) was found in the treatment combination T_4 where 100 % boro rice (Var. BRRI dhan29) plus 100 % BARI Sarisha-17 were mixed cropped. Cost and return analysis revealed that the combination of BRRI dhan29 plus BARI Sarisha-17 (T_4) gave the highest gross return (Tk.143250.00 ha^{-1}) and gross margin (Tk.70710.00 ha^{-1}) compared to the other mixed cropped combinations and it was also superior from sole cropping of boro rice or sole mustard.

Performance of selected rapeseed-mustard genotypes under salinity condition in coastal area

The experiments was conducted at two locations; Agricultural Research Station (ARS), BARI, Benarpota, Satkhira and On-Farm Research Division, Daulatpur, Khulna during the *rabi* season of 2016-17 to select salt tolerant mustard genotype under salinity condition. There were eleven varieties/genotypes namely *Brassica campestris*: SAU-01, BD-6950, BD -10115, BD -7104; Brassica napus: Nap-0564, Nap-0567, BARISarisha-8; *Brassica juncea*: BJDH-12, Jun-536, BARISarisha-11and BARI Sarisha-16. The yield and yield contributing characters of mustard varieties/lines was significantly influenced by the soil salinity. The highest seed yield (2.12 t/ha) was recorded in BD-6950with higher BCR (2.32) and the lowest seed yield (1.39 t/ha) was recoded in SAU-01 in Satkhira location. At Kulna, BARI Sarisha-16 and BJDH-12 line from cluster 3 were found superior (1.89t/ha) regarding agronomic characters. The lowest level (3.32 ds/m) of soil salinity was recorded in the sowing time and the highest level (10.45 ds/m) was in the harvesting stage in Satkhira location. Among the eleven genotypes BD-6950, Jun-536, BJDH-12, BARISarisha-11and BARISarisha-16 showed more salt tolerance at all the salinity levels in respect of root-shoot growth and yield performance.

Disease Management

Prevalence of fungi associated with mustard seed

A lab experiment was conducted at Pathology Laboratory of ORC, BARI, Joydebpur during 2016-2017 to identify the associated fungi with farmers saved mustard seed. Seed samples were collected directly from the farmers house at different locations of Khulna, Jessore, Jhenaida, Gopalgonj, Tangail, Kishoregonj and Norsingdi districts of Bangladesh. The seed samples were stored at refrigerator until the use.Six fungal genera viz.*Alternaria* sp., *Aspergillus flavus*, *Aspergillu sniger*, *Fusarium* sp., *Curvularia* sp., *Rhizopusstolonifer* and *Penicillium* sp. were found to be associated with seeds. The percent seed borne infection was ranged from 3.67% to 21.66%. *Alternaria* sp. *Aspergillus flavus*, *Aspergillus niger* and *Fusarium* sp. were present in all samples. The highest infection of *Alternaria* sp. was recorded in seeds of Jhenaida area which was 21.66. The lowest infection of *Penicillium* sp. was recorded in seeds of Jessore and Tangail which was 3.67%. The percent of germination of collected seed samples were more than 90 % except one location. The highest percent of germination 94% was recorded from Norsingdi seed.

Screening of rapeseed-mustard varieties/lines against *Alternaria* blight

The experiment was conducted at Oilseed Research Centre, BARI, Joydebpur during rabi 2016-2017 cropping season. Thirty one (31) lines of different *Brassica* spp (*B. rapa,B. napus* and *B. juncea)* were used in the study. Seeds were sown on 11 November, 2016 with three replications.. A susceptible variety Tori-7 was used in the experiment as infector. Every test lines were sown in two rows of 2 m long separated by single row of susceptible infector (Tori-7). *Alternaria* blight of mustard scored according to 0-5 scale. The scale was 0= leaves free from leaf spot (HR), 1= 0.1-6% leaf or pod area diseased (R), 2= 6.1-12% leaf or pod area diseased (MR), 3= 12.1-25% leaf or pod area diseased (MS), 4= 25.1-50% leaf or pod area diseased (S) and 5= above 50% leaf or pod area diseased (HS).

Among the 31 test lines; only three lines (NAP-205, BJ-66(y) and BARI Sarisha 11) were showed resistant reaction and sixteen lines (NAP-10015, NAP-1005, , NAP-10012- 1, BARI Sarisha 13, NAP-11008, NAP-10009, NAP-10017 BC-05115, BC-100614(4)-9, BC-100614(7)-2, BJDH-05, BJDH-20, BJDH-01, BJ-1111536, BJ-1111536(12)-1 and BJ-1111536(12)-5 were showed moderately resistant reaction to the disease. These lines can be used as breeding materials for development resistant variety.

Screening of rapeseed-mustard lines for resistance to *Orobanche*

An experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during 2016-17 to observe the magnitude of resistance of 31 oilseed *Brassica* germplasms namely BJ-1111536, BJ- 1111536(12), BJ- 1111536(7)-1, BARI-Sharisha-11, BJ-1111536-9-2, BJ-1111536-12-5, BJ-DH-05, BJ-1111536-12-5, BJ-66(Y), BARI-Sharisha-16, Nap-1007, Nap-10014, Nap-0660, Nap-10017, Nap-1005, Nap-0762, Nap-0885, Nap-0865, Nap-0876, Nap-0733-1, BC-100614-84, BC-99-22, BC-05-118, BC-100614(4)-12, BC-100614(4)-7, BC-100614(4)-9, BC-0-5115, BC-100614(3)-1, BC-100614(4)-2, BC-100614(4)-5and Tori-7 against *Orobanche*. Among the evaluated germplasms, six lines/varieties viz. BARI-Sharisha-11, BJ-1111536-9-2, BJ-DH-05, BARI-Sharisha-16, BC-100614(4)-12 and BC-0-5115 showed resistant reaction, 9 lines showed moderately resistant reaction and the rest of 16 lines including check showed susceptible reaction against *Orobanche.*

Efficacy of fungicides against Alternaria blight of mustard

An experiment was conducted during 2016-2017 cropping season in the field of ORC, BARI, Joydebpur and RARS Jessore to evaluate some fungicides in controlling *Alternaria* blight of mustard. Seeds of BARI Sarisha 14 was sown on November 2016. The experiment was designed in RCB with 3 replications where plot size was 3m x 2m with 30 cm row spacing .Seven different fungicides namely, Rovral 50WP (Iprodian), Amister top (Azoxytrobin + Difenoconazole), Antracol (Dithiocarbamate), Champion (Mancozeb), Rai (Azoxytrobin + Difenoconazole), Sundomil (Metaxyl +mancozeb) and Unisaf (Carbendazim+mancozeb) were sprayed. A control treatment was maintained for comparison. Rovral, Antracol, Champion, Sundomil and Unisaf were sprayed @ 0.2 % and Amister top and Rai were sprayed @ 0.1% at 10 day intervals beginning from the first appearance of the disease and continued to 3 times. Disease data was recorded 10 days after last spray on the basis of 0-5 scoring scale. Disease incidence, 1000 seed weight and seed yield (t/ha) were recorded .All the fungicides significantly reduced the disease as compared to control both the location. In Joydebpur location, the highest disease reduction was recorded from Rovral (84.45) sprayed plot followed by Amister top (81.12%) and Rai (79.45 %) sprayed plots. In RARS Jessore location, the highest disease reduction was recorded from Rai (83.53 %) sprayed plot followed by Rovral (81.76 %) and Amister top (76.47 %) sprayed plots. The highest yield (1583 kg/ha) was obtained from Rovral sprayed plot in Joydebpur location but the highest yield was obtained from Amister top (1734 kg/ha) sprayed plot in

RARS Jessore location. Considering benefit cost ratio the fungicide Amister top was found economic (3.35) followed by Rai (2.56) and Sundomil (2.46).

Amister top and Rai were effective fungicides for controlling the disease and increasing yield of mustard. The highest net profit of Tk. 16900 was obtained from the Amister top sprayed plot followed by Rai and Sundomil sprayed plot. This is the first year experiment. So, the experiment may be repeated in the next year for confirmation of the results.

Efficacy of fungicides against white mold disease of mustard

The experiment was conducted at the RARS, Ishurdi, Pabna during *rabi* season 2016-17 to find out the effectively of fungicides for controlling white mould /sclerotinia rot disease of mustard. The experiment was laid out in a RCB design with three replications. The unit plot size was 3m x 3m. Seeds of BARI Sharisa-14 were sown on 12 November 2016. The spacing was 30 cm x 5 cm. Seven fungicides where, T_1= Rovral 50 WP (Iprodione) @2g/l, T_2= Score 250 EC (Difenoconazole) @2ml/l, T_3=Folicur 250 EC (Tebuconazole) @2ml/l, T_4=Indofil M 45 (Mancozeb) @2g/l, T_5 = Contaf 5 EC (Hexaconazole) @2ml/l, T_6=Secure 600wg (Fenamidione + Mancozeb) @2g/l, T_7 =Tilt 250EC (Propiconazole) @1ml/l and T_8= Control were used in this experiment. All the fungicides showed significantly better performance over control. The lowest incidence of white mould disease (2.63%) was found in Folicur 250 EC (2ml/l) treated plots where as the highest (13.34%) was recorded in untreatedcontrol plots. Moreover, Folicur 250 EC (2ml/l) treated plots provided the highestyield (1.55t/ha). From the experimental results, it may be concluded that Folicur 250 EC (2 ml/l), Rovral 50 WP (2 g/l) and Tilt 250EC (1 ml/l) applied three times from the first appearance of the disease at an interval of 7 days found effective and economic in controlling of white mould (*Sclerotinia* rot) disease and increase yield of mustard.

Insect Pest Management

Field screening of rapseseed and mustard entries (*Brassica* spp.)

Against aphid (*Lipaphis erysimi* Kalt.)

Twenty six entries of rapeseed and mustard were evaluated against mustard aphid (*Lipaphis erysimi* Kalt.) under natural field condition during *rabi* 2016-17 at Oilseed Research Centre, BARI, Gazipur. The mustard entries were sown in November 23, 2016 in 2 m x 1m plot size in RCB design with three replications. Other intercultural operations were done as per recommendation of ORC. No insecticides were applied in the crop. Aphid populations were counted (in situ) from 10 randomly selected plants in each replicated plots on 10 cm twigs of the inflorescence at 7 days intervals. Three entries of B. rapa, namely BC-05115, BC-9921 and BC-05117 (7.12-12.32 aphids/plant) and three entries of *B. juncea* BJDH-01, BJDH-05 and BJDH-12 (9.21-20.2 aphids/plant) were found comparatively less aphid infestation than the check and other entries. From the result of this experiments, it was observed that *B. rapa* entries were attacked by the highest number of aphid while *B. juncea* had the lowest aphid infestation.

Role of honey bee on the yield and yield contributing characteristics of mustard (var: Tori 7)

The experiment was conducted in the farmers field of Ghior, Manikganj during rabi 2016-17. The experiment was sown in November 10, 2016 in 1212 sqm (30 decimal) of land, RCB design with three replications where beekeepers set their beehives for honey production. This investigation consists of the experiment i.e. impact of bee pollination on the yield and yield components of rapeseed variety Tori 7. In bee pollinated (BP) plants, the number of pods per plant, number of seeds per pod, weight of 1000 seeds (g) and yield Kg/ ha were recorded 9.33%, 27.27%, 11.42 % and 20.4% higher than the naturally pollinated (NP) plants, respectively. Bee pollination is the most effective and cheaper device for seed production of rapeseed and mustard crop. Mustard crop with honey bee rearing in beehive produced about 20% higher seed yield than without honey bee treated mustard crop and also get 25-30 kg of honey per beehive.

Survey and documentation of different insect pollinators of mustard

The study was conducted in the field of Oilseed Research Centre,BARI, Gazipur and the farmers field at Manikganj during *rabi* 2016-17 to document and identify the insect pollinators of mustard. The diversityof insect visitors was recorded by ahand net and visually .Sweeps were made at peak blooming period of mustard crop everyday,at fixed time intervals(7,9,11,12am and 1, 3 pm).The abundance of*Apis mellifera* persq.m.area wasre corded athourly intervals from same as before during the blooming period ofthe crop. Result indicated that a total of 11 insect pollinators belonging to order Hymenoptera (5), Diptera (3),Odonata (01) and Coleoptera (01) were found to visit the mustard crops at the flowering stage blossoms ORC, BARI, Gazipur and the farmers field of Manikgonj. The abundance (percentage of bees/m^2/2min.) of Hymenopterans insects were maximum followed by the Dipterans and others. Eleven insect pollinators were recorded in mustard crop.This study provide insights diversity of pollinating insects to help pollination in mustard an important crop in Bangladesh. Most of the pollinators were active during 11:00 AM to 01:00 PM at maximum flowering stage.

Sesame

Hybridization in sesame

A total of 88 pods were harvested from 419 pollinated buds out of four crosses. On an average 21% crosses were successful. The pollinated pods will be grown in the next year for F_1confirmation. However, the percent of success was low due to excessive rainfall occurred during seed emerging stage resulting less population and also in pod filling stage.

Observation trial of sesame

Eleven entries of sesame including one check variety of BARI Til-4 were evaluated for yield and yield contributing traits viz. days to 50% flowering, days to maturity, plant height, pods/plant, seeds/pod, thousand seed weight and yield. The genotype Ses-JP-21was most dwarf entry. The genotype Ses-0265followed by the genotype Ses-81 and Ses-76 produced remarkable seed yield compared to the check variety BARI Til-4. Four genotypes Ses-0265,Ses-81, Ses-76 and BT-2xBT-3-8 (black)have been selected for PYT.

Preliminary yield trial of sesame

Twelve entries including one check variety BARI Til-4 were evaluated in a RCB design with 3 replications at Oilseed Research Centre, Joydebpur, Gazipur, Regional Agricultural Research Station, Ishurdi,Pabna and Regional Agricultural Research Station, Jessore during *kharif*, 2017. At Joydebpur among the lines, significant variations were observed for the characters of plant height, pods per plant,seeds per pod and seed yield kg/ha. Days to 50% flowering ranged from 41-45 days and days to maturity ranged from 89-93 days. Plant height ranged from 124.6-154.4 cm. Ses-115 was the tallest and Ses-0570 was the most dwarfs among the tested lines. Number of pods per plant ranged from 61-88. The highest number of pods per plant was recorded in Ses-79 followed by Ses-JP-25 and Ses-52. Eight or four chambered capsule was recorded in the same plant. Seed yield ranged from 1026-1426 kg/ha. Ses-70 gave the highest seed yield. Over three locations seed yield indicated that Ses-70 showed the highest mean yield performance at Joydebpur,Ishurdi and Jessore followed by the genotype Ses-115 and Ses-78. Among other entries Ses-65,Ses-JP-24 performed better than check BARI Til-4 at Ishurdi and Ses-5at Jessore. Ses-70, Ses-115, Ses-78, Ses-65, Ses-JP-24 and Ses-5 were selected for RYT.

Regional yield trial of sesame (Set-I)

Nine entries of sesame including two check varieties of BARI Til-3 and BARI Til-4 were evaluated in a RCB design with 3 replications at Oilseed Research Centre, Joydebpur,Gazipur, Regional Agricultural Research Station,Ishurdi,Pabna and Regional Agricultural Research Station,Jessore during *kharif*, 2017. Nine entries of sesame including two check varieties of BARI Til-3 and BARI Til-4 were evaluated for yield and yield contributing traits viz. Days to 50% flowering, days to maturity, plant height, pods/plant, seeds/pod, thousand seed weight and yield. Over locations considering seed yield and other yield contributing characters three entries Ses-65, Ses-05115and Ses-14were selected for adaptive trial.

Regional yield trial of sesame (Set-II)

Nine entries of sesame including two check varieties of BARI Til-4 and BINA Til-1were evaluated in a RCB design with 3 replications at Oilseed Research Centre, Joydebpur,Gazipur, Regional Agricultural Research Station,Ishurdi,Pabna and Regional Agricultural Research Station,Jessore during *kharif*, 2017. At Joydebpur significant variations were observed among the lines for plant height, pods/plant, seeds/pod and grain yield kg/ha (Table 3). Days to 50% flowering and days to maturity ranged from 42-43 and 88-90 days. Plant height ranged from 114-147.2 cm. The highest plant height was recorded in Ses-05163 and the lowest plant height was recorded in the Ses 2010-01R. The genotype Ses-JP-47 produced the highest number of pods per plant. Seed yield ranged from 1032-1493 kg/ha. At Joydebpur the genotype Ses-JP-58(Y)gave highest seed yield. Over three locations mean days to maturity ranges from 88-91 days and seed yield ranges from 896-1220kg. The genotype Ses-JP-58(Y) gave higher yield than check BARI Til-4. Considering white seed coat colour, seed yield and other yield contributing characters, the genotype Ses-JP-58(Y), Ses-JP-47(Y), Ses-JP-25(Y) and Ses-JP-69(Y) were selected for adaptive trial in the next year.

Disease management

Evaluation of different management practices in controlling stem rot of sesame

The experiment was conducted to find out the effective method in controlling stem rot of sesame (at ORC Joydebpur) during kharif-I season of 2016-2017. Seeds of BARI Til-3 were sown on 07 March, 2016 and harvested on June 11, 2017.The experiment was designed in RCB with 3 replications where unit plot size was 3m x 2m.with 30cmx 10 cm spacing. Irrigation and other intercultural practices were done as and when necessary. Eight treatments were included in this experiments. The treatments namely T_1= Both seed treatment and foliar spray with Bavistin 50 WP (Carbendazim); T_2= Seed treatment and Spray with provax (Carbonix&Thiram) T_3= Seed treatment and Spray with Timsen(quaternary ammonium);T_4= Seed treatment with Onion bulb extract (1%w/v); T_5= Seed treatment with Onion bulb extract (1%w/v) and spray with Bavistin 50 Wp ; T_6 = Poultry refuse in the soil @ 6 t/ha before 20 days of planting was applied; T_7=Poultry refuse in the soil @ 6 t/ha before 20 days of planting was applied and Bavistin 50 WP spray and T_8=Control were maintained for comparison. The fungicides were sprayed three times at 10 days interval. Disease data were taken before fifteen days of crop harvest.

From the result of the experiment it may be concluded that soil amendment with poultry refuse and spraying with Bavistin 50WP followed by both seed treatments and spraying were done with Bavistingave lowest percent plant infection and also produced the highest yield and yield attribute of sesame. This was the second year trial So, the experiment will be repeated in the next year for confirmation of the result

Insect Pest management

Development of management option against hairy caterpillar in sesame

The field experiment was conducted at the Oilseed Research Centre, BARI, Gazipur during Kharif-1, 2016-17crop season. BARI Til 4 was sown on 10-03-2017 in 3m X 4m size plots following RCB design with 3 replications. Five treatments 01. Hand picking of infested leaf with larvae + Azadirachtin (Bioneem plus 1 EC @1 ml/L), 2. Cypermethrin + Chlorpyrifos (Nitro @ 2ml/l), 3. Spinosad (Success 2.5 SC@ 1.2 ml/l), 4. *Baccilus thuringiensis* Bt powder @ 0.4g/litre, 5. Untreated control. Percent leaf infestation were counted from the different treatments at 7 days (After spray) intervals during crop growing season in 3 frequencies. Yield data and Marginal Benefit Cost Ratio (MBCR) of the treatments were calculated. Data were analyzed statistically. Among the treatments, application of Bt powder @ 0.4g/litre of water reduced the highest infestation (87.74%) of hairy caterpillar and produced the highest seed yield of sesame (1.4 t /ha) with calculated the highest MBCR (10.42).

Groundnut (*Arachis hypogaea* L.)

Varietal Improvement

Maintenance and evaluation of groundnut germplasm

A total of one hundred nineteen genotypes were grown in a non replicated trial at Gazipur to evaluate the collected materials for future use in the breeding program. The sowing date was 15 December 2016. Seeds were sown in two rows of 4 m long plot with the spacing line to line 30cm and plant to plant 15 cm. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of NPKSZnB, respectively. A total of one hundred thirty nine (139) genotypes were evaluated and maintained just to rejuvenate the seeds of germplasm. The highest CV% was observed from the character mature pods per plant followed by 100 karnel weight (g). Minimum variation was observed in the character days to maturity. The characters plant height (cm) and plot yield kg/ha) showed moderate variation. The seeds of the germplasm were stored for using in the future breeding programme.

Creation of genetic variability of groundnut through hybridization

A total of 572 buds were pollinated at Joydebpur. On an average 38% crosses were successful and produced 216 pods. Crossed seeds collected to be grown as F_1 in the next winter season. Two batches of six parental lines were sown on twelve days interval in 21 December 2016 and 04 January 2017 at Joydebpur. The seeds of individual parents were planted in raised bed of 2 rows x 2m long with the spacing 50 and 20cm between rows and plants respectively. After the flower initiation, the crosses have been attempted. The unopened matured buds were emasculated at afternoon (12.00 pm to 2.00 pm) and the emasculated buds were pollinated in the following morning (6.00 am to 8.00 am.).

Evaluation of segregating generations of groundnut

Seeds of nine combinations from F_1, seven entries from F_2, three entries from F_3 and thirty four entries from F_5 respectively were sown on December 15, 2016 at Joydebpur. Unit plot size was 4m long with required number of rows. Recommended doses of fertilizers were applied and necessary steps were taken to grow the crop uniformly. On the basis of number of mature pods per plant, cluster pod formation, dwarf canopy of the plant, pod surface and diseases and insect reaction a number of single plants as well as bulk populations from different cross combinations of different segregating generations were selected. A total of 23 single plants, 25 single plants, 9 single plants and 140 single plants were selected from F_1, F_2, F_3 and F_5 generations, respectively. The seeds from selected single plant of F_1 was collected and stored for advancing the generation as F_2 in the next season. On the other hand the seeds from single plant of F_2 was collected and stored according to the cross and generation will be advanced as F_3 generation. From the F_3 generation 9 plants were selected as single plant from 3 accessions and will be tested their performance as F_4 generation in the next season. From the F_5 generation 140 plants were selected as single plan from 34 accessions which will be tested their performance as F_6 generation in the next season.

Observation trial of groundnut

Eighteen genotypes including two checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur during Rabi 2016-17. Seeds of the entries were sown on December 15, 2016 in RCBD design with 2 replications. Unit plot size was 2 rows 4 m long with the spacing of 40cm x 15cm between rows and plants, respectively. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of NPKSZnB, respectively.

The genotype (502-4-3-1, Choko 0314 and 14-303) was most dwarf entry (35 cm) compared the check variety Dhaka-1(36 cm) (Table 3). Maximum shelling percent were found in the genotypes ICGVS 38-

3(83%), 502-4-3-1 (81%)and ICGVS SL-1 (78%). Highest pod yield of 2169 kg/ha was obtained from the genotype ICGVS 38-3 followed by the genotype Chinabadam-8 (1983 kg/ha) and ICGVS SL-1 (1974 kg/ha) which were 43%, 31% and 30% higher than the check variety Dhaka-1, respectively. The genotype ICGVS 38-3 also produce 9% higher than the HYV BARI Chinabadam-8. Other three entries ICGVS 15-1, PK-1 and 6112-6-1 also produced the 27%, 23% and 22% higher yield, respectively than the check variety Dhaka-1. Maximum mature pod per plant was observed for the entries ICGVS 38-3 (33) followed by the entries 702-6-2-1 (31). Highest kernel weight of (59g) was obtained from the genotype PK-1 followed by the genotype ICGVS 38-3 (53g). Considering the per hectare yield and shelling percentage seven genotypes ICGVS 38-3, ICGVS SL-1,ICGVS 15-1, PK-1, 602-7-4-2, 502-4-3-1 and 6112-6-1 have been selected for PYT in the next year.

Preliminary yield trial of groundnut (set-i)

The experiment is conducted with seventeen groundnut genotypes including 2 checks as Dhaka-1 and BARI Chinabadam-8 at Joydebpur, Burirhat and Ishurdi locations in a randomized complete block design with 3 replications. Unit plot size was 5 rows 4m long with the spacing of 40cm between rows and 15 cm between plants. Recommended doses of fertilizers were applied @ 80:65:60:20:4 kg/ha of NPKSZn, respectively.

The significant differences were observed among the genotypes for all the characters studied at Joydebpur. Maturity duration ranged was 145-151 days. The genotype TG 51was most dwarf entry (31cm) compared to the check variety Dhaka-1 (39 cm) for character plant height. Highest number of mature pods/plant (31) was obtained by the entry ICGV-95090. The range of hundred kernel weight 29-43g which indicated the entries ICGVS 35-1, ICGV 91176, ICGV 87073 and NCGV 0207 were bold seeded genotype. Highest shelling percentage was recorded in the genotype ICGV-95090 (83%) followed by the entries ICGV 02841 (77%) and BARI Chinabadam 8 (76%). The Genotype ICGV-95090 produced the maximum pod yield (2045 kg/ha) followed by TG 37 (2023 kg/ha) and BARI Chinabadam-8 (1897 kg/ha) which were 25%, 24% and 16% higher than the check variety Dhaka-1, respectively. The genotype ICGV-95090 and TG 37 produced 7% and 6% higher seed yield, respectively than the high yielding variety BARI Chinabadam 8. The released variety BARI Chinabadam-8 (1897 kg/ha) also produced 16% highest yield than the check variety Dhaka-1. On average days to maturity ranged from 152-159 days. Average pod yield over the location ranged from 1351-2003 kg/ha. The entries ICGV 91176 produced maximum pod yield (2003 kg/ha) followed by NCGV 0107 (1941 kg/ha) and NCGV 0704 (1932 kg/ha) which were 41%, 37% and 36% higher than the check variety Dhaka-1, respectively. Average performance of released variety BARI Chinabadam-8 (1697 kg/ha) which is 19% higher than the check variety Dhaka-1.

Regional yield trial of groundnut (set-1)

The experiment was conducted at Joydebpur, Jamalpur and Burirhat during rabi 2016-2017 with 16 promising genotypes of groundnut including 3 checks Dhaka-1, BARI Chinabadam-8 and BINA Chinabadam-4. All the genotypes were collected from ICRISAT, India. The experiment was laid out in Randomized Complete Block design having three replications. The plot size was 4m x 2m. Seeds were sown on the 15 December, 2016 in 15cm seed to seed and row was 30 cm apart from each. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MP, Gypsum and Boric acid.

The experiment was conducted with sixteen selected lines of groundnut along with three check variety Dhaka-1, BINA Chinabadam-4 and BARI Chinabadam-8 which collected from ICRISAT, India. Shelling percent was the highest in the genotype ICGV-07219 and ICGV-02005 followed by ICGV-06423.The genotypes ICGV-06237, ICGV-06285 and ICGV-07220 takes maximum days to maturity than the checks. The genotype ICGV-91114 produced the maximum yield followed by ICGV-07219 and BINA Chinabadam-4 at Joydebpur.The genotype ICGV-91114 produced the higher yield followed by ICGV-07219 and BINA Chinabadam-4) which were 27%, 25% and 22% higher than the check variety Dhaka-1in Joydebpur location. Over the three location the genotype ICGV-00338 produced the maximum yield followed by BARI Chinabadam-8and BINA Chinabadam-4.

Regional yield trial of groundnut (set-2)

Twelve entries including two checks Dhaka-1 and BARI Chinabadam 8 were evaluated at Joydebpur, Jamalpur, Ishurdi, Jessore, Rahmatpur and Hathazari. Seeds of different entries were sown on December 15, 2016 in a RCB design having 3 replications in Joydebpur. Unit plot size was 4 rows 5 m long with the spacing 40 cm x 15 cm between rows and plants, respectively. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of NPKSZnB, respectively.

Twelve entries including two checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur. Days to maturity for the genotypes ICGV-01080 was more than the check variety Dhaka 1. Maximum shelling percentage was recorded from the genotype NCGV 05096 followed by ICGV-00338 and ICGV-01080. The entry ICGV-00338 produced the maximum pod yield followed by ICGV-96346 and NCGV 05096 which were 34%, 27% and 25% higher than the check variety Dhaka-1, respectively. The entry ICGV-00338 produced the maximum yield in Joydebpur while the entry ICGVS 36-1 in Ishurdi, the entry NCGV 05096 in Jamalpur and the entry ICGV 02096 in Rahmatpur. Average days to maturity of four locations were almost similar to the check varieties. On an average the entry NCGV 05096 produced the maximum yield followed by NCGV 0504 which were 51% and 48% higher than the check variety Dhaka-1, respectively.

Crop Management

Effect of storage conditions on the seed quality of groundnut stored in different containers

Experiments were carried out at Oilseed Research Centre, BARI, Gazipur during the period 2015-16 and 2016-17 to evaluate the suitable storage container for groundnut seed preservation and to find out the effect of storage period on the seed quality of groundnut under ambient condition storing. Five types container : i) Plastic container, ii) Polythene bag, iii) Tincontainer , iv) Gunny bag and v) Earthen pot were used in this experiment. Experiments were conducted for six month (from September to February). Results revealed that tin, plastic container and polythenebag were found less permeable to moisture transmission compared with gunny bag and earthen pot. Tin container showed the maximum germination capacity with high germination percentage and vigour index; where as gunny bag showed the lowest seed germination capacity during the testing period. The highest moisture content, electrical conductivity and abnormal seedlings were recorded in gunny bag; where as the lowest values of these parameters were recorded in tin container. The moisture content, electrical conductivity and abnormal seedlings were increased with advanced of storage period.Germination percentage, vigour index, oil and protein content in seed were decreased with the increase of storage periods. Among the five containers, tin and plastic container were the best and the gunny bag was the worst storage containers for groundnut seed storage for long time because the rate of moisture absorbance was higher in gunny bag than tin container, plastic container and polythene bag.

Intercropping black cumin with groundnut

A field experiment of intercropping black cumin with groundnut was conducted in Oilseed Research Centre, BARI, Gazipur during rabi season of 2016-17to find out the optimum row arrangement of black cumin as intercropping with groundnut for higher productivity and return. Six treatments were T_1= Sole groundnut, T_2= One row black cumin (15x10 cm) in between two normal rows of groundnut (40x15 cm), T_3= Two rows of black cumin in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of black cumin, T_5= Three rows of groundnut rows alternate with three rows of black cumin and T_6= Sole black cumin. Although intercropping reduced groundnut yield but total productivity was increased due to addition of black cumin yield. Total productivity in terms of groundnut equivalent yield (GEY) (5.04 t/ha) was obtained from T_3 treatment while the lowest (2.80 t/ha) in groundnut sole crop. However, highest benefit cost ratio (BCR) (7.8) was also recorded in T_3 treatment (Two rows of black cumin in between two normal rows of groundnut).

Disease Management

Screening of groundnut line(s) against leaf spot and rust diseases

An experiment was conducted at ORC, BARI, Joydebpur during *rabi* 2016-2017 under natural epiphytotic condition to evaluate groundnut entries to leaf spot and rust diseases. Twenty-three entries of groundnut were evaluated under natural epiphytotic condition against leaf spots and rust diseases using infector row method. Every tested genotypes were sown in two rows of 2 m long separated by single row of highly susceptible variety Dhaka-1 as infector. Disease severity was recorded using 0-5 and 1-9 scale respectively, for leaf spot and rust 15 days before harvest the crop. Ten plants from each entry were randomly selected, tagged and harvested separately for collecting data on yield contributing characters. Leaf spot disease was scored by using 0-5 scale where 0= no infection (HR), 1= Up to 10% leaf area infection ®, 2= 11-30% leaf area infection (MR), 3 = 31-50% leaf area infection (MS), 4= 51-75% leaf area infection (S), 5= 76-100% leaf area infection (HS).Again rust disease also recorded by using 1-9 scale where, 1= no pustules visible (HR), 3= few scattered pustules, usually seen after searching®, 5= pustules common on leaves and easily observed but causing no apparent damage (MR), 7= pustules very common and damaging, few pustules on petioles and stem (S) and 9= pustules very extensive on all plant parts, some death of leaves and other plant parts (HS).

Among the 23 tested lines only one line (ICGV-95456) showed highly resistant reaction and four lines (ICGV-00351, ICGV-34-3, ICGV-18-1, ICGV-3479-G-37, showed resistant reaction against rust disease. Five lines namely (ICGV-00351, ICGV-34-3, ICGV-18-1, ICGV-3479-G-37, and ICGV-9390) showed resistant reaction against leaf spot. Four lines (ICGV-00351, ICGV-34-3, ICGV-18-1, and ICGV-3479-G-37) showed resistant reaction to both leaf spot and rust diseases. These lines may be included in breeding programme for development disease tolerance variety.

Management of groundnut root rot by quality seed and fungicidal treatment

An experiment was conducted during 2016-2017 cropping season to find out the suitable management practice in controlling foot rot disease of groundnut in the field at ORC, BARI, Joydebpur. Chinabadam-8 was used as planting material. The experiment was designed in RCB with 3 replications where plot size was 3m x 2m. The spacing was 40 cm x 10 cm. Ten treatments were included in this experiments. Cleaned and apparently healthy seeds (discolour, shriveled and broken seeds removed) treated with the fungicides. Unclean seeds were planted without cleaning but treated with each of the fungicides .The treatments were: T_1= Clean seed + Seed treatment with Provax @ 2.5 g kg/seed, T_{2} = Clean seed + Seed treatment with Amistar top @ 2.5 g kg/seed, T_{3} = Clean seed + Soil application with Amistar top @ 2.0 g/L, T_{4}= Clean seed + Seed treatment with Bavistin @ 2.5 g kg/seed , T_5= Unclean seed + Seed treatment with Provax @ 2.5 g kg/seed, T_6= Unclean seed + Seed treatment with Amistar top @ 2.5 g kg/seed, T_7 = Unclean seed + Soil application with Amistar top @ 2.0 g/L, T_8 = Unclean seed + Seed treatment with Bavistin @ 2.5 g kg/seed, T_9 = Clean seed (control-1), T_{10}= Unclean seed (control-2). Foot rot incidence was recorded through regular monitoring and counting up to crop maturity.

All the treatment gave significant reduced of foot rot of groundnut which ranged 13.33-30.67% .The lowest (13.33%) percent plant mortality was recorded from T_3 (Healthy seed +Soil application with Amistar top) treatmentfollowed by T_1 (16.0) and T_2 (16.67)treatments and highest (30.67%) from control-2(T_{10}) treatment. The highest pod yield was recorded from T_3 (1476 kg/ha) treatment which was statistically similar with T_1 (1382 kg/ha) and T_2 (1363 kg/ha) treatments. The lowest (1123 kg/ha) pod yield was recorded from unclean seed control-2 plot (T_{10}).

Prevalence of fungi associated with groundnut seed

A lab experiment was conducted at Pathology Laboratory of ORC, BARI, Joydebpur during 2016-2017 to identify the associated fungi with groundnut seed in farmers saved seed. Seed samples were collected directly from the farmers house at different locations of Tangail, Karimgonj, Kisorgonj,Tarail,Nandail,Chilmari, Monohordi and Norsingdi districts of Bangladesh. The seed samples were stored at refrigerator until the use.five fungal genera viz. *Aspergillus flavus*, *Aspergillus niger*, *Fusarium* sp., *Curvularia* sp, *Rhizopusstolonifer*. And *Penicilliumsp* were found to be associated with seeds. The percent seed borne infection was ranged from 5% to 60%. *Aspergillus flavus ,Aspergillus niger* and *Fusarium*sp were present in all samples.. The highest infection of. *Aspergillus flavus* was recorded in seeds of Monohordi which was 60%. The lowest infection of *Penicillium* sp.and *Curvularia* sp. was recorded in seeds of Karimgonge and Kisorgonge which was 5 %. The germination percentages were recorded from 20 to 80 %. The highest germination percentage was recorded 80% which collected from Karimgong district.

Study on the relationship of environmental factors on the severity of tikka and rust disease and yield of groundnut

The experiment was conducted at ORC, BARI, Joydebpur with BARI Chinabadam-8 during rabi 2016-2017 to find out the relationship of disease development with temperature and relative humidity. The experiment was designed in RCBD with 3 replications where plot size was 3m x 2m. Fertilizer management, cultural and intercultural operations were done as recommended by Oilseed Research Centre (ORC), BARI. The spacing was 40 cm x 15 cm. The treatment were: T1=seed sowing at 1 Nov, T2= seed sowing at 1 Dec, T3= seed sowing at 1 January T4= seed sowing at 1 February, T5= seed sowing at 1March T6= seed sowing at 1April and T7= seed sowing at 1 May. The crop was allowed to grown under natural infection condition. Disease severity was recorded using 0-5 and 1-9 scale respectively, for leaf spot and rust before 15 days of crop harvestThe lowest PDI of both leaf spot (20.12) and rust (43.06) was recorded on December sowing followed by 1stJanuary sowing. Disease severity was increasing with delay of sowing from Yield and yield contributing characters were higher in December and January sowing but they were decreasing with delayed sowing. From the weather data it appears that during the month of December and January the average temperature was below 20^{0}c and then rises at March and later.

Insect Pest management

Field screening of groundnut entries against jassids and leaf roller

Twenty two groundnut entries of PYT & RYT were evaluated against jassid and leaf roller infestation during 2016-17 at ORC, BARI, Gazipur. The crop was sown on December 20, 2016 in a plot 3m x 4m size in RCB design with 3 replications. For evaluation of thrips damage, the total number of leaflets in five randomly sampled plants from the central two rows of a plot have been recorded and counted the number of leaflets showing thrips injury symptoms. Percent damage foliage for jassids and leaf roller was recorded by visual observations from the standing crop in natural field condition. The leaf infestation was recorded on 1st week of February 2017 at 15 days intervals at the vegetative, flowering and pod formation stages of the crop. The crop was harvested on May 25, 2017. Yield data of the entries were also recorded. Data were compiled and analyzed. Injury rating for both jassids and thrips on 1-9 scale supplied by ICRISAT. Of these, eight entries namely, ICGV-0935, ICGV-38-3,, ICGV-95090, ICGV-35-1, ICGV-86124, ICGV-05098 ICGV-9634 and ICGV-05456 were found comparatively less jassids and (10-20% leaf infestation) and leaf roller (8-12% leaf) infestation and produced higher yield than the other entries and cheeck variety Dhaka-1(30% leaf for jassid and 15%

Soybean *(Glycine max* L.*)*

Varietal Improvement

Maintenance and evaluation of soybean germplasm

A total of eighty two genotypes were grown in a non replicated trial at Gazipur to evaluate the materials for future use in the breeding program. The sowing date was 01 January 2017. Seeds were sown in two rows of 4 m long plot with the spacing line to line 40cm and plant to plant 10cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MoP and

Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the urea was applied as top dress during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth.

The ranges for days to flowering, plant height, number of pods per plant, 100 seed weight, yield per plot and days to maturity were 57-73 days, 24.8-77.2 cm, 2-160, 2-18 g, 60.25-1600 kg/ha and 93-144 days respectively. The per cent highest coefficient of variation (CV%) was recorded for the character yield per plot (82.81) followed by pod per plant (54.68) respectively. Minimum variation was observed in the character days to flowering and maturity. The character 100 seeds weight and plant height showed moderate variation.

Observation trial of soybean

Ten entries including one check variety namely BARI Soybean-6 were evaluated in a RCB design with two replications for seed yield and it's components at Gazipur during *rabi* 2016-17. The unit plot size was 2 rows of 4 m long and the spacing was maintained 40cm between rows and 10 cm between plants. The sowing date was 01 January 2017. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS respectively, from Urea, TSP, MoP and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done as and when necessary.Data on days to maturity and seed yield per plot were taken on the plot basis. The other yield contributing characters such as plant height, pod/plant and 100 seed weight (SW) were recorded from 5 randomly selected plants of each plot. Recorded data were analyzed statistically.

The entries USDA 40, USDA 53 and USDA 80 required minimum days to mature (104-109 days) while the entry USDA 85 took maximum days to mature (134 days). The most dwarf entry was Australia (16cm). Maximum plant height was recorded in B2 (58cm) followed by USDA 53 (57 cm) and USDA 95 (49 cm) while in check variety BARI Soybean 5 (43 cm). The entry USDA 95 produced the highest pods 76 per plant followed by USDA 85 (75). Majority of the selected entries could not exceed the yield of the check variety BARI Soybean 5.Two entries USDA 53 and USDA 95 produced 26% and 5% higher yield than the check variety BARI Soybean-5.

Preliminary yield trial of soybean

Eight entries including one check variety viz. BARI Soybean-6 were evaluated in a RCB design with three replications for seed yield and it’s component at Gazipur during rabi 2016-17. The unit plot size was 6 rows of 4 m long and the spacing was maintained 40cm ×10cm. The sowing date was 01 January 2017. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from urea, TSP, MoP and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done as when necessary. The yield contributing characters were recorded from 5 randomly selected plants of each plot. Seed yield was converted into kg/ha. Recorded data were analyzed statistically.

The genotype USDA-4 was the most dwarf (18 cm) while BARI Soybean-6 and USDA-72 showed maximum plant height (41 cm). Maximum number of pods per plant (61) was found in the entry USDA 72 while minimum number in USDA 4 (11). Hundred seed weight of USDA 11 and BARI Soybean 6 recorded 14g were the maximum and statistically different from the remaining entries. None of the entry could overcome the yield from the check variety. The genotype USDA 60 took maximum days to mature (145 days) followed by USDA 93 (121 days) while the check variety BARI Soybean 6 took 111 days to mature. The genotypes USDA 4 took 97 days to mature.

Regional yield trial of soybean

Nine entries including two check varieties viz. BARI Soybean-5 and BARI Soybean-6 were evaluated in a RCB design with three replications for seed yield and it’s component at Gazipur during rabi 2016-

17. The unit plot size was 6 rows of 4 m long and the spacing was maintained 40cm ×10cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from urea, TSP, MoP and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done as when necessary. The yield contributing characters were recorded from 5 randomly selected plants of each plot. Seed yield was converted into kg/ha. Recorded data were analyzed statistically.

The genotype Givency and Santarose were the most dwarf (25 cm) while LG-92P-11-76 was the tallest (55 cm) in plant height. Maximum no. of pods per plant (27) was found in the entry GMOT-17 while minimum number in Givency (14). Hundred seed weight of Givency, AGS-95 and BARI Soybean 6 recorded 15g were the maximum statistically different from the remaining entries. Three entries GMOT-17, AGS-79 and KUSH 2004 produced higher seed yield than both the check varieties. The highest seed yield was obtained by the entry GMOT-17 (1800 kg/ha) followed by AGS-79 (1510 kg/ha) and KUSH-2004 (1450 kg/ha) which were 76%, 47% and 42% higher than the check variety BARI Soybean 6. The genotype GMOT-17 took the maximum days to mature (117 days) followed by AGS-79 (116 days) while the check variety BARI Soybean 5 took 109 days to mature. The two genotypes Santarose and Givency took 94 and 97 days to mature, respectively.

Crop Management

Performance of selected genotypes of soybean under rainfed condition

An experiment was conducted at research field of oilseed, BARI during rabi season 2016-2017 to evaluate the response of rainfed on morphological and yield of soybean. Ten genotypes were considered for the study. Rainfed/drought stress showed significant influence on growth, yield contributing characters and yield. Among the different genotypes, Asset-95 gave the maximum 100 seed weight (9.83g) and the lowest(5.00g) was obtained from USDA-53 under rainfed situation. The highest seed yield (1171kg/ha) and stover yield (1971kg/ha) were obtained from Asset-95genotype and the lowest seed yield(609kg/ha)and stover yield (1301kg/ha) from BARI Soybean -6. Among the different genotypes, Asset-95, BARISoybean-5, Shohag, USDA-22, USDA-53, AGS-95 and BS-32 performed better under rainfed situation.

Disease Management

Screening of soybean genotypes against soybean yellow mosaic virus

The experiment was conducted during 2016-2017at Joydebpur to find out the resistant lines of soybean yellow mosaic virus. A total of twenty one lines/variety of soybean were tested. A susceptible variety Sohag was used as standard check. Foliar disease was recorded at the pod development stage using 0-8 scale. Among the 20 test lines; only one line (AGS 205)showed highly resistant reaction against soybean mosaic virus, seven lines (BS-29,COLOMBUS,USDA-93,UDSA-47,GMOT-13, VIETKHAI and TAS-4)showed moderately resistant reaction to Soybean yellow mosaic virus disease .These lines will be further evaluated in the next season.

Management of soybean yellow mosaic virus (SYMV) through vector control by insecticide spray

An experiment was conducted during 2016-2017 cropping season to evaluate some insecticides in controlling yellow mosaic virus disease of soybean in the field at Oilseed Research Centre, BARI, Joydebpur and RARS, Barisal.The experiment was designed in RCB with 3 replications where plot size was 2m x 2m with 40 cm row spacing. Fertilizer and other intercultural operations were done uniformly as per recommendation of ORC to raise a good crop. Five different insecticide namely, T_1= Malathion 57EC @2ml/L of water,T_2= Admire 200SL@0.25ml/L of water, T_3 = Aktara25WP @ 0.2gm/L of water,T_4 = Tafgor 40EC @2ml/L of water and T_5 = Bioneem plus 1EC @1ml/L of waterwere sprayed. A control treatment was maintained for comparison. All insecticides were sprayed at 10 day intervals beginning from the first appearance of the disease and continued to 3 times. Disease data was recorded 10 days after last spray on the basis of 0-8 scoring. All the insecticides significantly reduced the disease as compared to control both the location. In Joydebpur location, the highest disease reduction was recorded from Malathion (48%) sprayed plot followed by Aktara (43%) and Admire (38%) sprayed plots. In RARS Barisal location, the highest disease reduction was recorded from Aktara(40%) sprayed plot followed by Malathion(34%) and Bioneem plus (33%) sprayed plots.The highest yield (1.65 t/ha) was obtained from Malathion sprayed plot in Joydebpur location but the highest yield was obtained from Aktara (2.8 t/ha) sprayed plot in RARS Barisal location.Considering benefit cost ratio the Admire was found to be economic (8.12) followed by Malathion (6.54).

Insect Pest Management

Development of management package against the major insect pests of soybean

The field experiment was conducted at the Oilseed Research Centre, BARI, Gazipur during 2016-17. BARI soybean-6 was sown on 10-1-2017 in 3m X 4m size plots following RCB design with 3 replications. The treatments are 1. Hand picking of infested leaf with larvae + use of sex pheromone of *Spodoptera litura* + Azadirachtin (Bioneem plus 1 EC @1 ml/L)+ Spinosad (Success 2.5 SC@ 1.2 ml/l). 2. Hand Picking+ Alternate spray of Azadirachtin (Bioneem plus 1 EC) and Diazinon 60 EC@ 2 ml/l **,** 3. use of Chlorpyrifos + Cypermethrin (Nitro @ 2ml/l) 4. Untreated control. Number of *spodoptera* adult was collected from the pheromone trap in every 7 days intervals from 3rd week of January to, 1st week of March 2017. Percent leaf infestation were counted from the different treatments 7 days (After spray) intervals during crop growing season in 3 frequencies. Yield data were recorded and MBCR of the treatments were calculated. The highest infestation reduction of pest complex of soybean (common cutworm, leaf roller, pod borer and hairy caterpillar) was found 92.10% recorded in hand picking + Sex pheromone of *S. litura* +Azadirachtin + Spinosad treated plots and produced the highest seed yield (2.2 t /ha) of soybean with calculated the highest Marginal Cost Benefit Ratio (MBCR) (2.35).

Field screening of soybean entries against leaf roller and hairy caterpillar

Twenty (20) entries of soybean were evaluated against leaf roller, hairy caterpillar, and common cut worm infestation during 2016-17 at ORC, BARI, Gazipur. The crop was sown on 01 January 2017 in a plot of 3m x 2m in RCB design with 3 replications. Percent damage foliage for leaf roller and hairy caterpillar was recorded by visual observations from the 10 randomly selected plants per plot and counted infested and healthy leaves from each entry in natural field condition. The leaf infestation was recorded by different insect pests on first week of February 2017 and continued up to 3rd week of March 2017 at 15 days intervals at the seedling, vegetative, flowering and pod formation stages of the crop. Data were recorded, compiled and analyzed. Of these, eight (8) entries namely, AGS-205, Asset-93, GMOT -13, GMOT-95, GMOT-17, BS-29, MACS-BR-18 and Givency were selected for comparatively less infestation (10-15% leaf) caused by leaf roller and hairy caterpillar than the other entries and check variety BARI Soybean-6.

Sunflower (*Hellianthus annus* L .)

Varietal improvement

Maintenance and evaluation of sunflower germplasm

Twenty five sunflower genotypes as well as BARI Surjamukhi-2 (check) were grown at the research field of ORC, BARI Gazipur on 20 November 2016. Seeds were sown in 2 rows x 3 m long plot, maintaining row to row distance 50 cm and plant to plant distance 25 cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Pollen of each entry within a plot was collected and bulked. Then crossing was done within the genotypes of that plot. After crossing, bagging was done properly. Other intercultural operations were done when necessary to obtain optimum plant growth. BARI Shurjomukhi-2 and BD9361 took minimum days to mature (98 days). BD9386-1 was the most dwarf one among the genotypes. Maximum number of seeds/head and highest seed weight/head was found in GP-04026 (827) and in BD9360 (71g), respectively. Highest CV% was recorded for the parameter seed weight/head followed by number of seed per head.

Development of dwarf inbred lines in sunflower

i) Advancing s_6 to s_7 generations

Two hundred and sixty eightS_6 single plants of nine sunflower genotypes were grown at Gazipur. Seeds were sown on 21 November 2016 in ORC research field. Seeds were sown in 2 rows of 4 m long plot where the spacing was 50cm between the rows and plant to plant 25 cm. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. To obtain optimum plant growth other intercultural operations were done properly when necessary. Individual plants were selected for selfing and bagging. Pollen were collected and roughed within the same head by hand during selfing. Data were recorded on days to 50% flowering, days to maturity, average plant height (cm), stem diameter (cm), head diameter (cm), numbers of seeds/head and seed weight/head (g) and 1000 seeds weight (g) from five randomly selected plants in each entry.

A total of 268 heads of nine sunflower genotypes were self-fertilized. The data on days to 50% flowering, days to maturity, average plant height (cm), stem diameter (cm), head diameter (cm), numbers of seeds/head and seed weight/head (g) and 1000 seeds weight (g) were recorded. From each S_7 entry, five randomly selected plants were harvested in bulk. The bulked seeds from each entry will be grown in the next season and will be allowed to inter mating by open pollination in isolation to develop desired sunflower inbred lines.

ii) Advancing S_2 to S_3 generations

A total of three hundred and seven S_2 single plants of eleven sunflower genotypes were grown at Gazipur. Seeds were sown on 24 November 2016 in ORC research field. Seeds were sown in plant to row method of 4 m long plot where the spacing was 50 cm between the rows and plant to plant 25 cm. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. To obtain optimum plant growth other intercultural operations were done properly when necessary. Individual plants were selected for selfing and bagged properly for escaping prevention of out crossing. Pollen were collected and roughed within the same head by hand brush during selfing. Data was recorded on average plant height (cm), stem diameter (cm), head diameter (cm), seeds/head, and seed weight/head (g).

A total of 307 heads of eleven sunflower genotypes were self-fertilized. The average plant height, head diameter, seeds/head and seed weight/head was recorded. A total of forty one single plants were selected based on plants height close to 100 cm along with head diameter close to 15-20 cm to advance generation as S_4. A total of fifty three single plants were selected and will be evaluated as S_3 generationsnext year.

Observation trial of sunflower

Three sunflower entries including one check BARI Surjomukhi-2 were evaluated following RCB design for yield and yield contributing traits at Gazipur during the Rabi season of 2016-17. Seeds were sown on 21 November 2016 and unit plot size was 6 rows x 4 m long with spacing 50cm row to row and 25cm plant to plant. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and the other fertilizers were applied at the time of final land preparation. The remaining half of the urea was applied as top dress during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth. Data on days to maturity and seed yield were taken on plot basis. The other yield contributing characters were recorded from 10 randomly selected plants of each plot. Seed yield taken on plot basis and was converted into yield/ha. Recorded data were analyzed statistically. The most dwarf entry was P-S-2-2(B) and this entry gave highest thousand seed weight (53g). The highest number of seeds/head and highest seed yield was obtained from BARI Surjomukhi-2.

Regional yield trial of sunflower

Nine sunflower lines along with check variety BARI Surjamukhi-2 were evaluated for yield and yield contributing traits at Gazipur, Jessore, Ishurdi and Rahmatpur during the Rabi season of 2016-17. Seeds were sown at these locations on 21, 11, 09 November 2016 and on 03 December 16 respectively. Experiments were laid out in RCB design with 3 replications. Unit plot size was 10 m^2. Each plot consisted of 4 rows which were 4 m long with 50 cm row to row and 25 cm plant to plant spacing. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, Data on days to flowering, days to maturity and seed yield were taken on plot basis. The other yield contributing characters were recorded from 10 randomly selected plants of each plot. Seed yield was converted into yield/ha. Data on plant height and seed yield of the four regions were analyzed combined. Recorded data were analyzed statistically by using SAS 9.1 software.

Significant differences among the genotypes were observed for all the yield contributing characters except days to flower and thousand seed weight at Gazipur location. The most dwarf genotype was BHAC 04026 (85 cm). The highest head diameter was recorded for BARI Surjamukhi-2 and BHAC 04032(19 cm). SVS-00901 produced the highest number of seeds/head (682). On the other hand, maximum thousand seed weight was obtained from SUN-W-103 (68 g) followed by SVS-00901 (65 g). The entry SUN-W-103had given higher yield than check variety BARI Surjamukhi-2 all over the location except at Rahmatpur, Barisal.

Identification of parental lines for development of hybrid variety in sunflower

S_1seeds of CN001, CN002, CN003 and S_3 seeds of Hysun-33 were used as experimental material in this experiment. Seeds were sown on 22 November 2016 in ORC research field in two rows of 4 m long with the spacing of 50 cm between the rows and plant to plant 25 cm. Anthers in flowers were observed visually. Plants having prominent anthers along with pollen grain in flowers were identified as pollen fertile plants. On the other hand, plants having rudimentary anthers without pollen grains or absent of anthers in flowers were identified as CMS plants. CMS plants were crossed with selected pollen fertile plant (male parent) and selected male fertile plants were self-fertilized. Data on total number of plants, number of pollen fertile plants, and number of CMS plants were recorded.

A self-fertilized plant P2 of hybrid CN002 produced 100% fertile plant which might indicated that this would be a restorer plant of that hybrid.

A 100% CMS plant was produced from a self-fertilized pollen fertile plant (E) of hybrid Hysun-33, which may indicated that this plant E could be a maintainer line of hybrid Hysun-33. From the same hybrid, a cross between a CMS plant and a pollen fertile plant J gave 100% fertile plant which might indicated that this pollen fertile plant J could be a restorer line of this hybrid. Therefore, a hybridization program can be taken to develop hybrid sunflower variety using these lines. However, further investigation is needed for confirmation of this results.

Development of synthetic and composite sunflower variety

i) Development of synthetic sunflower variety

Eight inbred lines of sunflower were grown in a non-replicated trial, self-fertilized and allowed to intermate by open pollination in isolation at the research field of ORC, BARI Gazipur on 24

November 2016 to develop synthetic sunflower variety. Seeds were sown in 2 rows x 4 m long plot, where row to row distance was 50 cm and plant to plant distance was 25 cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Pollen of each entry within a plot was collected and bulked. Then crossing was done within the genotypes of that plot. After crossing, bagging was done properly. Other intercultural operations were done when necessary to obtain optimum plant growth.

The data were recorded from ten randomly selected plants for different characters. The ranges for days to flower, days to maturity, plant height (cm), stem diameter (cm), head diameter (cm), seeds/ head, seed weight/head (g) and 1000 seed weight (g) were 61-68, 94-103, 65-109 cm, 1.6-2.2 cm, 12.8-21.6 cm, 174-435, 9.46-27.90 g and 40.77-70.79g, respectively. These inbred will be grown and all possible single crosses (diallel crosses) will be made in the next rabi season and will be evaluated for GCA of yield and other characters in replicated trial using local check.

ii) Development of composite sunflower variety

An equal number of seeds from eight inbred lines of sunflower viz: P-S-2-OP1, P-S-2-OP2, P-S-2-OP3, P-S-2-OP4, P-S-2-OP6, P-S-2-OP8, P-S-2-OPa and P-S-2-OPb were mixed together grown and allowed for intermating to develop dwarf composite sunflower variety at the research field of ORC, BARI Gazipur on 24 November 2016. Seeds were sown in 10 m x 10 m plot, maintaining row to row distance 50 cm and plant to plant distance 25 cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done when necessary to obtain optimum plant growth.

During the growing season, the undesirable types were discarded to achieve uniformity and homogeneity in various morphological characters. The data were taken from 10 randomly selected plants on days to flower, days to maturity, plant height (cm), stem diameter (cm), head diameter (cm), seeds/ head, seed yield/head (g) and 1000 seeds weight (g). The plants were harvested in bulk as composite-1 and kept for growing as composite-2 in the next rabi season.

Development of dwarf high yielding sunflower variety through induced mutagenesis

Seeds of two sunflower inbred lines P-S-2 and SVS019001 along with a released variety BARI Surjamukhi-2 were treated with gamma rays (Gy) at 100, 200, 300, 400 and 500 Gy doses. The irradiation treatment was carried out in the laboratory of Institute of Food and Radiation Biology, Ganakbari, Savar. A total of 200 seeds from each genotype were used as control in this study. All irradiated and non-irradiated seeds were grown at the research field of ORC, BARI Gazipur on 22 November, 2016 to generate M1 population in 6 rows × 4 m long plotmaintaining50 cm×25 cm row to row and plant to plant distance, respectively. Plot of each treatment was covered with mosquito net to prevent outcrossing and self-fertilization was done within the treatment. M1 plants were evaluated by comparing with non-irradiated plants for survival, plant height (cm) (at 21DAS, 30 DAS and at maturity), head diameter (cm), stem diameter (cm), number of seeds/head and yield/head (g) from 10 randomly selected plants. Growth abnormalities were observed and recorded for the M1 generation compared to the WT plants. Among the three genotype, BARI Surjamukhi-2 was found to be more tolerable to gamma radiation where at least a 20% plant were survived up to maturity against at the rate of 300 Gy. It is noted that drastic plant lethality was observed at this dose (300 Gy) for the other two genotypes. Plant height was measured at 21 DAS, 30 DAS and at maturity both for irradiated and non-irradiated control plants. An increment of plant height was observed for all genotypes at the irradiation dose of T1 (100 Gy) compared to that of their control for most of three stages of plant growth. However, decreasing rate of plant height was observed with the increasing doses of irradiation for all the three genotypes after T1 dose.

Stem diameter was found to be increased up to a certain level of Gy treated plants compared to its non-treated plants though it does not follow a gradual increment trend, but a decreasing trend was observed in the subsequent dose in all genotypes. A similar trend was also observed for the character head diameter.The number of seeds per head and seed yield per head was found to be reduced in most of the treated plants compared to that of their non-treated plants. Besides, a number of altered phenotypes were observed in this study such as such as exactly dwarf plant (28 cm), branched mutants, multiple head mutants, splitting head mutants, fused flower, twin flower and upright flower.

Crop Management

Relaying sunflower with T. aman rice at different sowing dates in coastal area

An experiment was conducted at the farmer's field (Harodda, Vomra, Satkhira) during the rabi season of 2016-2017 to find out the optimum sowing time of relay sunflower with T. amam rice for increasing the yield of sunflower in coastal area. There were five treatments viz. T_1 = Dibbling sunflower seed in T. aman rice(25 days before T. aman harvest), T_2 = Dibbling sunflower seed in T. aman rice (20 days before T. aman harvest), T_3 = Dibbling sunflower seed in T. aman rice (15 days before T. aman harvest), T_4 = Dibbling sunflower seed in T. aman rice (10 days before T. aman harvest) and T_5 = Sowing sunflower after harvesting of T. aman rice (control). The highest seed yield (1.98 t/ha) was recorded in T_4 (Dibbling sunflower seed in T. aman rice (10 days before T. aman harvest))with higher level of BCR (2.05) and the lowest seed yield (1.25 t/ha) was recorded T_1 (Dibbling sunflower seed in T. aman rice(25 days before T. aman harvest), The lowest level of soil salinity was recorded at sowing time (3.05dS/m) in T_1 (Dibbling sunflower seed in T. aman rice(25 days before T. aman harvest), and the highest level of soil salinity was recorded in harvesting stage (10.05 dS/m) in T_5(sunflower after harvesting of T. aman rice (control)

Performance of sunflower (*Helianthus annuus*L.) varieties in southern region of Bangladesh

The experiments was conducted three locations; Satkhira, Potuakhali and Pirozpur during the rabi season of 2016-2017 to identify the suitable variety of sunflower in southern region. There were four varieties viz. Hisun-33 (BRAC), Imported, BARI surjamukhi-2 and Hybrid (syngenta). The highest seed yield (2.46 t/ha, 2.54t/ha) were recorded inHisun-33 (BRAC) and 2.00 t/ha was recorded in BARISurjamukhi 2 with higher level of BCR in Satkhira, potuakhali and Pirojpur respectively. The lowest level of soil salinity was recorded in the sowing time (4.22dS/m) and the highest level of soil salinity was recorded in the harvesting stage (10.42 dS/m).

Insect management

Record of S*podoptera litura* infestation on sunflower at Gazipur

Sunflower is the most important oil crop in the world. Now a day's popularity of sunflower oil is increasing also in Bangladesh. It is mainly grown in rabi season in Bangladesh. Six insect pests have been recorded in sunflower in Bangladesh but common cutworm was not found in sunflower before. This cropping season (2016-17) the pest was found at the research field of oilseed research centre, BARI, Gazipur. The population was observed in the 1st week of January to last week of January, 2017 at seed formation to early maturity stage. Initially the young larvae feed the leaves and then immature seeds from the heads. It was observed that single spray of SNPV@ 2 gm/10 litre of water was successfully control (about 98%) of *S. litura* population at ORC research plot at Gazipur.

Linseed (*Linum usitatissimum* L.)

Maintenance and evaluation of linseed germplasm

Twenty linseed genotypes including check variety Neela were evaluated and maintained at the research field of ORC, Joydebpur during rabi 2016-17. Seeds were sown on November 23, 2016. The unit plot size of each genotype/line was 4 m long with 4 rows maintaining 40 cm and 10 cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P:

K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly.

Among the genotypes Neela was the most dwarf l ine. Neela, Lin-1903, Lin-103 and JL-2 flowered early.Lin-1503/2 produced maximum number of pods/plant. The highest 10 plants' seed yield (g) was observed in Lin-803 followed by Lin-1503/2.

Niger (*Guizotia abyssinica* Cass)

Maintenance and evaluation of niger germplasm

Twenty genotypes of Niger including the released variety Shova were evaluated and maintained at the research field of ORC, Joydebpur during rabi 2016-17 Seeds were sown on November 23, 2016. The unit plot size of each genotype/line was 4m long with 4 rows maintaining 40cm and 10cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly.

Among the genotypes NIG-7706, NIG-5306, NIG-140/6, NIG-9206 and NIG-1306 flowered early (51 days) and the genotypes NIG-7706, NIG-5306, NIG-140/6, and NIG-5806 matured early.NIG-7506 was the most dwarf genotype. Maximum number of pod/plant and seed yield was observed in NIG-2506.

Safflower (*Carthamus tinctorius* L.)

Maintenance of safflower germplasm

Six genotypes of safflower including the check variety BARI Saff-1were carried out at the research field of ORC, BARI Joydebpur during rabi 2016-17 with. Seeds were sown on November 23, 2016. Each genotype was grown in a 4m long x 6 rows plot, maintaining 40cm and 10cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MoP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly. Seeds of these genotypes were collected and preserved properly for evaluation and maintenance in the next year.

Observation trial of safflower

Four safflower lines including one check variety BARI Saff-1 were evaluated for yield and yield contributing characters at ORC, Gazipur during rabi 2016-2017. All the entries gave significant result in case of days to flower, days to maturity and plant height. Seeds were sown on November 23, 2016. Each genotype/line was grown in a 4m long with 4 rows unit plot maintaining 40cm and 10cm spacing between rows and plants respectively. Experiments were laid out in RCB design with 2 replications. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MoP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly. Maximum number of pod/plant and seed/pod were observed in SAF-504. Highest seed yield were found SAF-502 and SAF-503 as compared to BARI SAFF-1. Further evaluation is needed for these lines for the development of a new safflower variety.

Post harvest and Biochemical Studies

Physicochemical properties, oxidative stability and fatty acid composition of rice bran oil blends

The study was conducted during the period from October, 2016 at Central laboratory of Oilseed Research Centre (ORC), BARI, Gazipur. Rice bran oil (RBO) is non-conventional oil which has been found to improve the stability of the blended oil due its nutrient composition. The purpose of present study was to develop a healthier and stable blend using rice bran oil and other conventional oils. Therefore, four rice bran oil blends were prepared in two ratios i.e. 80:20 and 70:30. These rice bran oil blends were analyzed for fatty acid composition, oxidative stability, and antioxidant activity. Consequently, RBO + sunflower and RBO + soybean oil contained highest amount of monounsaturated fatty acids (45.99% and 42.67%) and polyunsaturated fatty acids (33.51% and 36.47%), respectively in the ratio of 70:30. Saturated fatty acids were found to be highest (33.07%) in RBO + palm oil (80:20). Rice bran oil + palm oil (70:30) showed least percent increase in peroxide formation 25.14 % and the highest amount of peroxide formation RBO + sunflower oil and RBO + soybean oil showed 48.13% and 55.24% in ratio (70:30), respectively. Oryzanol content was found to be highest in RBO + sunflower oil and RBO + soybean oil i.e. 2696.04 µm/kg and 2691.79 µm/kg (80:20). RBO + Sunflower oil (70:30) contained highest amount of monounsaturated fatty acids, and adequate amount of natural antioxidants.

Determination of aflatoxin content in maize using HPLC UV-Detection method

Aflatoxins are mycotoxins that are produced by fungi in the genus *Aspergillus*, including *A. flavus*, *A. parasiticus* and *A. nomius*. Not only are these compounds extremely toxic, but they are also mutagenic, teratogenic (causing abnormalities) and carcinogenic effects in human and animals. Aflatoxin determination levels in maize or foods were great importance to adjust the ingestion of nutrients by the population. The purpose of this study was to determine the content/concentration of total aflatoxins in foods or maize. The analysis was performed using High Performances Liquid Chromatography (HPLC). The values expressed aflatoxins were76.89 µg/kg for aflatoxins B1, 167.86 µg/kg for aflatoxins G1 and 27.15 µg/kg for aflatoxins G2 in maize sample, respectively. This method can be used to measure the content/concentration of aflatoxin not only maize but also measure groundnut, cereal seeds, walnut, wheat and almonds.

Growth, Physiological, and Biochemical responses of sunflower genotypes under salinity condition

The experiment was carried out during the period from April, 2017 at net house and Central laboratory of Oilseed Research Centre (ORC), BARI, Gazipur to examine the variation of salt tolerance of selected sunflower genotypes in vegetative stage. Seeds of three sunflower genotypes (GP-04017, CN-012 and BARI Sunflower 2) were tested for their salt tolerance at different level of salinity (control, 8 and 12 dS m^{-1}). Results revealed that salinity stress drastically affected the physiological and chemical attributes of all sunflower genotypes under all levels of salinity. GP-04017 genotype was found leading genotype at high level of salinity (12 dS m^{-1}) by showing less reduction in all plant growth attributes i.e. plant height (46.58%), plant biomass (83.20), SPAD value (21.68) relative to percent of control treatment. The results of our experiment clearly indicated that GP-04017 can perform well followed by BARI Sunflower 2 and genotype CN-012 is sensitive to salinity. The amount of proline was increased in salt tolerant lines. The genotype GP-04017 has high growth and was accumulating more proline in comparison with other genotypes.

Onion

Varietal Improvement

Advanced yield trial of onion

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2016 -2017 with a view to select good onion lines in respect of bulb shape, bulb skin colour, neck thickness and shelf life. Four onion advanced lines (ON0328, ON0329, ON0374 and ON0375) with BARI Piaz-1 and BARI Piaz-4 were used in this study. The experiment was laid out in a randomized complete block design with three replications. It was recorded that BARI Piaz-4 given the highest plant height (40.90 cm) followed by ON0374 (39.33 cm) and ON0375 (38.23 cm) and the lowest (32.00 cm) was found from BARI Piaz-1. BARI Piaz-4 given the highest number of leaves per plant (8.77) followed by ONO329 (8.63) and ONO375 (7.83) and the lowest number of leaves per plant (6.83) was found from BARI Piaz-1. It was found that BARI Piaz-1 gave the lowest neck diameter (0.99 cm) which was followed by ONO374 (1.00 cm) and ONO375 (1.02 cm) and the highest was found in BARI Piaz-4(1.35 cm). BARI Piaz-4 gave the highest bulb yield (15.94 t/ha) followed by ONO374 (15.57 t/ha), ONO375 and (14.50 t/ha).The lowest bulb yield was found from ON0328 (11.77 t/ha). It was observed that ON0329, ON0374, ON0375 and BARI Piaz-1 were moderately resistant and ON0328 and BARI Piaz-4 were moderately susceptible to purple leaf blotch disease.

Evaluation of summer onion germplasm

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2016 -2017 with a view to select superior summer onion germplasm for higher yield and good keeping quality. Ten onion germplasm (ON0358, ON0359, ON0360, ON0361, ON0362, ON0363, ON0364, ON0365, ON0366 and ON0367) were used in this study. The experiment was laid out in randomized complete block design with three replications. It was found that the highest plant height (79.77 cm) was observed in ON0365 and the lowest (62.22 cm) was found from ON0360. The germplasm ON0361 gave the highest number of effective flowering stalk (6.02) at 90 DAP and the lowest (1.89) was found in ON0362. The highest seed yield per plant, 1000 seed yield and germination percentage (8.87g, 4.60g and 87.67%, respectively) was found in ON0364 and the lowest seed yield per plant, 1000 seed yield and germination percentage (3.88 g, 2.60 g and 70.33%, respectively) were recorded from ON0362. In case of disease severity, it was found that ON0359, ON0364 & ON0365 showed moderately resistance and ON0360, ON0361, ON0362 & ON0366 were susceptible to purple leaf blotch disease.

Development of onion variety through random crossing and mass selection

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2016 -2017 with a view to create diverse source of population for developing superior onion variety with good keeping quality. Five onion variety viz. BARI Piaz-1(winter type), BARI Piaz-2(summer type) BARI Piaz-3 (summer type), BARI Piaz-4 (winter type) and BARI Piaz-5 (summer type), advanced lines of C4 cycle with ten summer onion germplasm (ON0358, ON0359, ON0360, ON0361, ON0362, ON0363, ON0364, ON0365, ON0366 and, ON0367) were used in this study. The experiment was none replicated. It was found that line L6 (C4 cycle) gave the highest seeds yield per row (147 g) and the lowest seed yield per row (62 g) was recorded from L_3. The highest germination percentage (79) was observed from L_6 lines and the lowest (67) was found from L_3. At maturity, seeds were harvested, processed and stored for further study.

Performance of onion advanced lines tolerence to thrips

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2016-2017 with a view to select winter onion lines/varieties tolerant to thrips and having good yield potential. Two onion lines ON0326, ON0332 with BARI Piaz-1 and BARI Piaz-4 were used in this study. The experiment was laid out in randomized complete block design with five replications. The tallest plant (42.14 cm) was recorded from BARI Piaz-4 and the lowest plant height was found from ON0332 (36.06 cm). It was reported that BARI Piaz-1 gave the lowest neck diameter (0.86 cm) and the highest neck diameter (1.15 cm) was found from BARI Piaz-4. BARI Piaz-4 gave the highest bulb diameter and single bulb weight (4.03 cm & 36.27 g, respectively) and the lowest (2.93 & 25.00 g, respectively) were recorded in ON0326. The highest bulb yield (16.47 t/ha) was obtained from BARI Piaz-4and the lowest bulb yield (12.00 t/ha) was found from BARI Piaz-1. The lowest thrips population per plant (5.32) was recorded in ON0332 and the highest thrips population per plant (15.82) was observed in BARI Piaz-1. The lowest thrips population indicated that the line is tolerant to thrips infestation. It was also noted that, the line ON0332 and BARI Piaz-1 was moderately resistant and ON0326 and BARI Piaz-4 were moderately susceptible to purple leaf blotch disease.

Performance of onion varieties in Char land

The experiment was conducted at different char land areas of Gaibndha district during 2016 -2017 with a view to evaluate the performance of onion varieties at char land areas and to promote the adoption of onion varieties among the char land farmers. Two onion varieties viz., BARI Piaz-1(winter type) and BARI Piaz-4 (winter type) were used in this study. It was found that BARI Piaz-4 gave the tallest plant (48.67 cm) while the shortest plant (38.68 cm) was recorded from BARI Piaz-1. The highest number of leaves per plant (10.67) was found from BARI Piaz-4 and the lowest number (8.40) was observed from BARI Piaz-1. BARI Piaz-4 gave the highest bulb yield (15.26 t/ha) and the lowest bulb yield (12.20 t/ha) was recorded from BARI Piaz-1.Due to heavy rain and disease at Baliagari char of Gobiadaganj Upazila most of the seedlings were damage.

Maintenance breeding of onion

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2016 -2017 with a view to maintain the varietal purity and to increase the breeder seed production of onion with quality aspect. Two onion varieties viz., BARI Piaz-1(winter type), BARI Piaz-4(winter type) were used in this study. The experiment was none replicated. It was observed that 10 Kg breeder seed and 20 Kg Truth Full Level Seeds (TLS) were obtained from BARI Piaz-1. About 5 Kg breeder seeds and 15 Kg TLS seeds were found from BARI Piaz-4. After harvest seeds were processed and stored for bulb production in the following year.

Regional yield trial of advanced onion line

The experiment was conducted at different Regional and Sub Centers of Spices Research Centers, during November, 2016 to March 2017 to study the performance of selected advanced onion line (AC Gaz 009) and BARI Onion1 at different AEZ. One advanced onion line (AC Gaz 009) with BARI Onion1 was used as check. The experiment was laid out in randomized complete block design with five replications.The advance onion line (AC Gaz 009) showed superiority in most of the yield attributing characters such as plant height, number of leaves, bulb length, single bulb weight, total bulb weight per plot and yield per hectare over the check variety BARI Onion 1.The other parameters such as days to bolting and harvest, number of leaves/plant and bulb diameter were found similar in both the lines. The advance onion line (AC Gaz 009) gave the highest yield (12.98 t/ha) and the lowest yield (9.02 t/ha) was found from BARI Onion 1.

Evaluation and selection of poly-crossed onion

The experiment was conducted at the Regional Spices Research Center, BARI during November, 2016 to April 2017 to evaluate the variability created in onion germplasm through poly-crossing method. Ten poly-cross onion genotypes (PC_2001, PC_2002, PC_2003, PC_2004, PC_2005, PC_2006, PC_2007, PC_2008, PC_2009 and PC20010) evaluated considering agronomic performances and yield parameters. The experiment was non-replicated. Lots of variations were observed in respect to bulb size, attractiveness, color and shape of bulb compared to their mother bulb characteristics. Mean bulb weight and average yield increased in second generation compared to first generation of polycross population but mostly decreased from original genotypes.

Purification and improvement of bari piaz-1 and bari piaz-4

The experiment was conducted at Spices Research Sub-Centre, BARI, Faridpur during rabi season of 2016-2017. The experimental field belongs to high land of Low Ganges River Floodplain (AEZ 12) with clay loam in texture. Two different shapes of bulb viz., flat and round of BARI Piaz-1 and three different shapes of bulb viz., globe, broad elliptical and spindle of BARI Piaz-4 were included for this study. The experiment was a non-replicated trial and no design was followed. The maximum seeds were obtained from BARI Piaz -1 round shape (42 g) and minimum seeds were obtained from BARI Piaz -1 flat shape (1.4 g). The collected seeds were harvested and stored separately. The seeds will be used for fourth generation bulb production in the next year.

Advanced yield trial of promising garlic line

The study was conducted at Spices Research Centre, BARI, Shibganj, Bogra during rabi Season 2016-2017 to select the promising garlic germplasm for releasing a variety. The experiment was laid out in RCB design with three replications. Four different garlic lines (GC0038, GC0035, GC0013 and GC0027) including BARI Garlic-1 as check were evaluated based on their yield and other desirable characters. The signification variation was found in plant height, number of leaves/plant, bulb length, bulb width, clove length, clove width, yield /plant and yield (t/ha). Considering all the characters, the lines GC0038, GC0035 and GC0013 were found promising. This is the first year study. So further evaluation will be needed for confirmation of the result.

Evaluation of garlic germplasm

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra during Rabi Season 2016-2017 to select the promising garlic germplasm for releasing a variety. Ten different garlic lines (GC001, GC005, GC0012, GC0028, GC0029, GC0030, GC0031, GC0042, GC0036, GC0040 and BARI Rashun-1 check as) were collected and evaluated based on their yield and other desirable characters. The experiment was laid out in RCB design with three replications. Among the lines, the highest yield (10.75 t/ha) was obtained from GC0036 and the lowest (5.14 t/ha) was found from GC001. Disease severity was also lower in GC0036. Significantly all the yield contributing characters were found better from GC0036.

Performance of winter chilli lines

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2016-2017 with a view to screen out promising chilli lines suitable for winter season and to increase chilli yield. Ten chilli lines viz., C0691 C0692, C0693, C0694, C0695, C0696, C0697, C0698, C0699 and C0700 were used in this study. The experiment was laid out in randomized complete block design with three replications. It was observed that the tallest plant (114.20 cm) was recorded from C0697 and the shortest plant (81.20 cm) was found from C0691. The lines C0699 and C0700 needs 56 days to produce 50% flower while the highest days (70 days) was needed by C0695 . The minimum days were needed to produce 50% mature fruits (110 days) by C0694 while the highest days were needed to produce 50% mature fruit (130 days) by C0691. The line C0692 gave the highest number of fruit per plant and the highest fruit weight per plant (173 and 470g, respectively) and the lowest (27 and 40g, respectively) were found from C0696. The highest fruit length (9.54cm) was recorded from C0700 and the lowest (5.63cm) was found from C07695. The lines C0691 and C0693 gave the lowest skin thickness (0.27mm) and the highest skin thickness (0.42 mm) was recorded from C0697.

Development of inbreed lines of chilli

The experiment was conducted at Spices Research Centre, Shibganj, Bogra during 2016-2017 with a view to develop inbreed chilli lines for future breeding program and to release suitable winter variety for green and dry chilli. Forty chilli lines viz., C0651 C0652, C0653, C0654, C0655, C0656, C0657, C0658, C0659, C660, C0661 C0662, C0663, C0664, C0665, C0666, C0667, C0668, C0669, C0670, C0671 C0672, C0673, C0674, C0675, C0676, C0677, C0678, C0679, C680, C0681, C0682, C0683, C0684, C0685, C0686, C0687, C0688, C0689 and C0690 were used in this study. The experiment was non-replicated. The highest plant height (146.20cm) was recorded from C0684 and the lowest plant height (66.00cm) was found from C0663. In case of days to 50% flowering, it was observed that C0654, C0673, C0683 and C0689 were given 50% flowering within 56 days and the highest days (80) was needed to 50% flowering by C0665, C0666,C0667 and C0684. The minimum days were needed to produce 50% mature fruits (110 days) from C0655, C0657, C0669, C0673, C0680 and C0686 and the highest days (131) were needed to produce 50% mature fruits from C0666 and C0667. It was observed that C0677gave the highest number of fruits per plant and the highest fruit weight per plant (177 and 420g, respectively) and the lowest of these parameters (29 and 50g, respectively) were found from C0685. Significantly the highest single fruit weight (3.39g) was found in C0687 and the lowest single fruit weight (0.94 g) was found from C0659. The highest fruit length (11.14cm) was recorded fromC0678 and the lowest fruit length (4.54cm) was found from C0672. It was observed that C0686 gave the highest 1000 seed weight (7.00g) and the lowest weight (3.00g) was found from C0688. The lowest skin thickness (0.20mm) was found in C0655 & C0661 and the highest skin thickness (0.43mm) was found in C0688 and C0689.

Maintenance breeding of chill

The experiment was conducted at Spices Research Centre, Shibganj, and Bogra during 2016-2017 with a view to maintain the varietal purity through maintenance breeding. Two chilli varieties viz., BARI Morich- 2 (year round) and BARI Morich-3 (winter variety) were used in this study. The experiment was non-replicated. Desired plants were selected according to the morphological characters of the mother parent. Red ripe fruits were collected from the specific characterized plants for maintaining varietal purity. After ripening seed were collected, processed and storage for future study. It was observed that the varieties of BARI Chilli-2 and BARI Chilli-3 performed 80-90% homogygocity on plant growth habit, fruit colour and fruit shape & size.

On farm adaptability trial of released chilli varieties in saline areas

Two BARI released Chilli varieties viz. BARI Morich-2 and BARI Morich-3 along with a local check cultivar (Bulet) were tested against salinity at MLT site Koyra during late rabi of 2016-2017. The experiment was laid out in RCB design with three replications. The Maximum soil salinity went up to 6.77. Yield and yield component of Chilli showed that significantly highest plant height (75.05 cm), number of fruits per plant (256.9), fruit length (6.52 cm), weight of fruits per plant (441.0 g) and green fruit yield (17.43 t ha^{-1}) were recorded from BARI Morich-2, which may be due to suitability of the variety in the late rabi condition.

Evaluation of different chilli lines for rainy season

The experiment was conducted during April to September, 2016 at Spices Research Sub-Centre, Faridpur to evaluate the performances of four chilli lines with BARI Morich-2 as check and to select the suitable planting time for rainy season. The experimental field belongs to high land of Low Ganges River Floodplain (AEZ 12) with clay loam in texture. The experiment was laid out in RCB design with three replications. Four lines and a variety viz., C0711, C0712, C0713 and C0714 and BARI Morich-2 as check were evaluated with three planting time viz., 01 April, 15 April and 30 April. Seedlings of 40 days old were transplanted maintaining of 50 cm × 50 cm spacing in each case. The crop (Green chilli) was started to harvest from July and completed on August-September, 2016. Among the lines, C0712 emerged as superior in terms of maximum number of fruits/plant (225.7) and weight of fruits/plant (478.6g) and fresh yield (15.43t/ha) while the highest single fruit weight (3.217 g) was found from C0714. The 15 April planting date emerged as best in terms of maximum weighed fruit (2.661g), weight of fruits/ plant (409.3 g), number of fruits/plant (182.5) and fresh yield (12.14 t/ha). The interaction effect showed that line C0712 transplanted on 15 April gave the heavier fruits/plants (542.2 g) with maximum number of fruits/plant (241.3)and maximum fresh yield (16.73 t/ha). The 15 April planting was ideal for rainy season chilli evaluation and the line C0712 was the most stable performing line with respect to different planting dates.

Screening of chilli genotype for salt toleance

A pot culture experiment was carried out at the Regional Spices Research Centre, Gazipur during 2016-17. The experiment was carried out in CRD design with three replications. Thirty eight genotypes of chilli (viz. BM-3, BM-2, C0631, C0632, C0633, C0634,C0635, C0636, C0637, C0638, C0639,C0640, C0641, C0642, C0643, C0611-1, C0611-2, C0525, C0525-1, C525-2, C0525-3, C0613, C0629, C030, C0446, C0446-1, BR-2, C0610, C0610-1, C0001, C0002, C0003, C0644, C0645, C0646, C0647 and C0648) were used for screening out salt tolerant one. Forty days old two healthy seedlings per pot were transplanted on December, 01, 2016 in plastic pots. Each pot contained 10 kg air dried sandy loam soil. After 15 days of transplantation, all pots were arranged for the treatments control and salt-stress (5 dS/m). Salinity level increased with the increase of days after transplanting of chilli and the highest soil salinity of 6.5 dS/m was measured at 90 days after planting. All plant characters were sharply decreased under salt stress. Among the different plant characters leaf and fruit weight were badly affected by salinity than others. Based on relative shoot dry weight, fruit dry weight and fresh fruit yield, the genotypes C0640, BM-2, C0446, C0629, C0644, C0611-1, C0446-1 C0641, C0637 and C0642 performed better than others.

Characterization and evaluation of ornamental chilli germplasm

The research was carried out at the experimental field of Spices Research Centre, Shibganj, Bogra during rabi season, 2015-16 and 2016-17 to identify chilli germplasm suitable for kitchen and roof top garden as ornamental and table purpose. The land was medium high and the soil was clay loam in texture. The unit plot size was 1.5m x 3m. Eleven ornamental chilli germplasm were characterized and evaluated for their performance. The experiment was non-replicated. The characterization was done according to “Descriptors for capsicum” by IPGRI, AVRDC and CATIE (1995). Among the chilli lines CS ORNA-03, CS ORNA-05 and CS ORNA-07 were evaluated in this year and other lines were evaluated for both years. Therefore the chilli line CS ORNA-01, CS ORNA-02, CS ORNA-10 and CS ORNA-20 were selected for regional yield trial for their good bearing habit and attractive looks.

Regional yield trial of promising ginger lines

The experiment was conducted at Spices Research Center, Bogra (L_1), Spices Research Sub Center, Lalmonirhat (L_2) and Regional Spices Research Center, Magura (L_3) during April 2016 to February 2017. Six promising ginger lines (G005, G006, G0027, G0024, G0035 and G002) were included in the study with BARI Ada-1 as check. The experiment was laid out in randomized complete block design with three replications. Significant differences among the ginger lines were observed in each location regarding different parameters. In case of location, the highest yield (29.40 t/ha) was recorded at SRC, Bogra, and the lowest yield was recorded (20.43 t/ha) at Magura location. In case of advance line, the highest yield (34.13 t/ha) was found from G0035 while the lowest yield (18.31 t/ha) was found from G006. The Combined effect of location × advance line gave significant effect on yield and other parameter. The highest yield (37.15 t/ha) was obtained from G0035 at Bogra location. While the lowest yield (13.21 t/ha) was obtained from G006 at Magura location. Significantly higher plant height, number of tillers/plant, number of leaves/plant and secondary rhizome, dry matter (%) and yield were observed better from the line G0035. In case of combined effect, the highest dry matter (31.48 %) was found from G0035 at Bogra location, the lowest dry matter (14.82 %) was obtained from G006 at Magura location.

Evaluation of ginger germplasm

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra during April 2016 to March 2017 to select the promising ginger germplasm for releasing a variety. Twenty one different ginger lines (G0045, G0043, G004, G0010, G0042, G0036, G0020, G0021, G0022, G0023, G0033, G0044,G0025, G0026, G0034, G0041, G001, G003, G0031, G0040, and G0032) with BARI Ada-1 as check were evaluated based on their yield and other characters. The experiment was laid out in randomized complete block design with three replications. Significantly the highest plant height number of tillers/plant, number of leaves/plant, weight of primary and secondary rhizome, and yield were observed in the line G0044. The highest yield (38.80 t/ha) was obtained from G0044 and the lowest (19.35 t/ha) was found from G0021 line.

Improvement of ginger through induced mutation

Sixty five pieces (individual weight: 35- 40g) of healthy rhizomes of BARI Ada-1 and one promising line G 0025 were exposed to 0, 5,10 and 15 Gy doses of gamma rays from the ^{60}Cobalt source of BINA, Mymensingh forM_1, M_2 and M_3 generations during April to February of 2014-2015, 2015-2016 and 2016-2017. In the year 2014, on 21 April, In M_1, days to 1st emergence gradually increased with increased doses of gamma rays in both studied materials. In contrast, the percentage of survived plants at harvest decreased with increased doses of gamma rays. Interestingly, no plants survived at harvest at 15 Gy doses of gamma rays treated rhizomes of any of the two parents. All the mutants performed better than their respective parents in terms of rhizome yield and all yield attributes in M2 and M3 generations and similar trend of results in both the generations was observed indicating the mutants are fixed. Therefore, rhizomes of all the plants of a mutant will be massed together and yield trial will be conducted in the next year.

Evaluation of turmeric lines

The experiment was conducted at Regional Spices Research Centre, Gazipur during April, 2016 to February, 2017 to select promising line/ lines for releasing turmeric variety. Five lines of turmeric including BARI Holud -5 were considered in this trial following RCB design with three replications. Fingers were used as planting material. The lowest days to 1st and 50% emergence (26 and 34 days, respectively) were recorded in T073-1 followed by T0116 (30 and 53 days respectively). T073-1 possessed the tallest plant (167.57 cm) followed by BARI Holud -5 (129.30 cm). Two lines (T0116 and T0119) produced maximum numbers of leaves/ hill which were statistically similar. The highest numbers of finger/hill were obtained from T073-1(21.20) followed by T0116 (20.70). Among the studied lines, T0119 possessed maximum number of mother rhizome/ hill (3.27) while T073-1 produced heavier finger (449.63g) and mother rhizome/ hill (112.0 gm). The highest fresh yield/hectare was recorded from T073-1(24.28 t) followed by T0116 (21.20 t), but the highest dry yield (4.93 t) was recorded from T0119 followed by T073-1(4.73 t). Most of the fingers were thin and narrow. The maximum size (length x breadth) of finger (9.40 cm x 2.0cm) was obtained from BARI Holud -5 while T073-1 possessed maximum length of mother rhizome (9.20 cm). The core color was found attractive (Yellow- Deep yellow-orange yellow) was in all lines. All turmeric lines except T0103-1 having 0.1-10.0 % necrotic leaf area for leaf blotch disease were found.

Evaluation of black cumin germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogra during rabi season of 2016-2017 to evaluate different germplasm collected from different sources and to identify the best germplasm with higher yield and other desirable characters. The experiment was laid out in RCB design with three replications. Nine different black cumin lines (BC01, BC03, BC04, BC05, BC06, BC07, BC08, BC09 and BC10) were evaluated against recommended variety BARI Kalozira-1. Seed yield and other yield contributing characters were significantly different except capsule/plant and capsule length. The highest seed yield (0.892 t/ha) was recorded in BC10 which was identical to BC09 (0.744 t/ha) and BC06 (0.697 t/ha). The lowest seed yield was recorded in BC04 (0.369 t/ha).

Evaluation of fenugreek germplasm

The trial was conducted at Spices Research Centre, BARI Shibganj, Bogra during rabi season of 2016-2017 to evaluate the germplasm which collected from different sources in terms of yield potential and crop duration and to identify the best one(s). The experiment was laid out in RCB design with three replications. Seventeen different fenugreek lines (FK01, FK07, FK08, FK09, FK012, FK014, FK015, FK016, FK017, FK018, FK021, FK022, FK023, FK024, FK025, FK27 and FK028) were evaluated against recommended variety BARI Methi-2. Seed yield and other yield contributing characters were significantly different among the germplasm. Among the germplasm, The highest seed yield 2.59 t/ha was achieved form the line FK25. Which was identical to FK28 (2.43 t/ha) and FK22 (2.23 t/ha). The lowest yield was found in FK17 (0.99 t/ha). On the other hand the germplasm FK 22 and FK 15 has shorter crop duration than the other germplasm, also produced satisfactory yield. So that, the germplasm FK22 and FK 15 may be selected for RYT.

Evaluation of fennel germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogra during rabi season of 2016-2017 to identify the best germplasm with higher yield and desirable characters. The experiment was laid out in RCB design with three replications. Eight different fennel lines with newly released variety (BARI Mouri-2, FN02, FN03, FN04, FN05, FN07, FN08, FN09 and FN10) were evaluated for yield and yield contributing character. Seed yield and other yield contributing characters were significantly different among the germplasm. The highest plant height was recorded from FN09 (149.4 cm) which was identical to FN02 (140.8 cm) and FN06 (141.9 cm). The higher seed yield was obtain from FN01 (1.86 t/ha) and FN06 (1.84 t/ha). The lowest seed yield was recorded from FN03 (1.07 t/ha).

Collection and evaluation of celery germplasm

The experiment was conducted at the research field of Spices Research Centre, Shibganj, Bogra during rabi season, 2016-17 to evaluate the performance of different celery germplasm and to select the promising one(s) for releasing a variety. The land was medium high and the soil was clay loam in texture. The experiment was laid out with a Randomized Complete Block Design with three replications. Five celery germplasm collected from different region of Bangladesh were tested for the experiment. It was found that all the parameters except plant height, number of umbel lets/umbel and 1000-seed weight was statistically significant. The largest quantity of seeds 862.2 kg/ha were harvested from the celery line CL 01 followed by CL 05 (732.2 kg/ha), CL 04 (712.8 kg/ha) and CL 02 (686.7). The smallest quantity of seeds (557.2 kg/ha) were harvested from the line CL 03.Considering the results, the celery line CL 03 and CL 05 were selected for regional yield trial in the next year.

Evaluation of cumin germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogra during rabi season of 2016-2017 to evaluate of cumin and identify the best germplasm with higher yield and other desirable characters for variety release. The experiment was laid out in RCB design with three replications. Nine different cumin lines (CN021, CN022, CN026, CN028, CN034, CN035, CN036, CN037 and CN038) were evaluated for yield and yield contributing character. Seed yield and yield contributing characters varied significantly among the germplasm. The highest number (87.16) of umbels/plant was recorded from CN026 and the lowest (38.20) was CN021. The highest seed yield was obtain from CN26

(606.70 kg/ha) followed by CN28 (523.10 kg/ha). The lowest seed yield was recorded from CN021 (243.50 kg/ha).

Evaluation of Indian bay leaf germplasm (cinnamomum tamala)

The trial was conducted at Spices Research Centre, BARI Shibganj, Bogra during rabi to kharif season-1 of 2016-17 four different Indian bay leaf lines to identify the best line(s) for variety release. The experiment was laid out in RCB design with four replications. Four different Indian bay leaf lines viz., CTB001, CTB002, CTB003, and CTB004 were used in this experiment. Among the lines the highest leaf length (17.44 cm), highest leaf breath (5.90 cm), lowest internodes distance (3.16 cm), and the highest leaf thickness (0.74 mm), highest dry matter (57.19%), highest petiole length (1.87 cm) and highest number of primary branches/plant (30.53) were recorded from CTB004. The lowest disease severity (PDI value: 3.93 in leaf spot and 4.53 in grey leaf spot disease) was recorded from CTB003 line and the highest disease severity was recorded (PDI value: 52.67 for leaf spot) from CTB002 and (PDI value: 39.07 for grey leaf spot) from CTB001.The highest leaf yield (green) (39.91 kg/plant/year was obtained from CTB 004 which was statistically similar to CTB003 (37.03 kg/plant/year).

Evaluation of betel leaf germplasm

This experiment was conducted at Spices Research Center, BARI, Shibganj, Bogra during 2015-16 and 2016-17 to select the promising betel leaf germplasm for releasing a variety. The land was medium high and the soil was sandy loam in texture. Twelve different betel leaf genotypes (BL 001, BL 002, BL 003, BL 004, BL 005, BL 008, BL0010, BL0012, BL 0016 and BL 0021) along with BARI Paan -1 and BARI Paan -2 (as check) were evaluated based on their yield and yield contributing characters. The experiment was laid out in Randomized Complete Block Design with three replications. In 2015-16, among the germplasm, the highest (218.60 cm^2 in kharif-2 & 180.50 cm^2 in rabi) leaf area was recorded from BL003 and the lowest (130.60 cm^2) leaf area was recorded from BL002 during kharif-2 season. In 2015-16, the maximum number of leaves (40.52 lakh/ha/years) was recorded from BL003 and the minimum number of leaves (27.25 lakh/ha/year) was recorded from BL002. The highest leaf (fresh) yield (21.58 t/ha/year) was recorded from BL003 and the lowest leaf (fresh) yield (11.22 t/ha/years) was recorded from BL002 in the same year. In 2016-17, the highest leaf area was recorded from BL003 (230.20 cm^2in kharif-2 and 199.10 cm^2 in rabi) and the lowest leaf area (145.40 cm^2 in kharif-2) was recorded from BL002, while in rabi it was recorded from from BL0016 (128.10 cm^2). The highest yield (40.60 lakh/ha/year and 22.45 t/ha/year) was recorded from BL003 and the lowest yield (27.71 lakh/ha/year) was recorded from BARI Paan-2.

Cultural Management

Development of spices based cropping pattern

A trial was conducted at SRSC; Lalmonirhat during 2016-17 to develop economically sustainable and profitable spices based cropping pattern(s) over existing pattern. Four alternate cropping patterns T. Aman-Fallow-Boro-Fallow, T. Aman-Garlic-Summer onion, T. Aman-Groundnut+Garlic- T. Aus and T. Aman-Summer onion- Mungbean-T. Aus were introduced against the existing cropping pattern T. Aman rice–Fallow–Boro rice–Fallow. The experiment was carried out in RCB design with 3 replications. The highest rice equivalent yield (38.96 t/ha) was obtained from the cropping pattern T. Aman-Garlic-Summer onion and the lowest (9.92 t/ha) was in the existing cropping pattern T. Aman rice–Fallow–Boro rice–Fallow. The highest gross return and gross margin was also obtained from alternate cropping patterns over existing pattern due to additional yield of new crops in the pattern.

Effect of different mulching on the yield and weed control of onion

The trial was conducted at Spices Research Sub-Centre, BARI, Lalmonirhat during rabi season 2016-2017 to study the effect of different mulch on the yield and weed control of onion. The experiment was laid out in RCB design with three replications. Three different mulch viz. straw mulch, water hyacinth mulch and saw dust mulch along with two times hand weeding (at 25 and 50 DAP) and no mulching no weeding treatments were studied. All the mulching treatments gave significantly higher yield (11.70-12.13 t/ha) than hand weeding (10.16 t/ha) and no mulching no weeding (1.70 t/ha). But the treatment saw dust mulch gave the highest yield (12.13 t/ha) and BCR (2.20).

Effect of integrated weed management on the yield of onion

The experiment was conducted at Regional Spices Research Centre, BARI, Magura during November, 2016 to March 2017 to determine the optimum dose of herbicides and management practices for onion cultivation. The treatments were viz, T_1- Oxadiazol 1.0 L/ha, T_2- Oxadiazol 1.5 L/ha, T_3- Oxadiazol 2.0 L/ha, T_4 -T_1 + HW at 45 DAT , T_5-T_2 + HW at 45 DAT,T_6 -T_3 + HW at 45 DAT, T_7 - Pendimethalin 1.0 L/h, T_8 - Pendimethalin 1.5 L/h , T_9-T_7 + HW at 45 DAT, T_{10} -T_8 + HW at 45 DAT, T_{11} -Weed free, T_{12}-Weedy check (control). The experiment was conducted in Randomized Complete Block Design (RCB) with three replications. Bari piaz- 1was used as a planting material. The results of the study revealed that application of herbicides with hand weeding had significant impact on yield and yield attributes of onion. The highest plant height, number of leaves/plant, neck diameter, bulb diameter, bulb length, bulb weight, yield was recorded from the T_6 treatment (Oxadiazol 2.0 L/ha + HW at 45 DAT). The highest yield 7.63 t/ha was obtained from T_6 (Oxadiazol 2.0 L/ha + HW at 45 DAT) while the lowest yield 4.22 t/ha was obtained from control.

Effect of irrigation on yield and storability of onion at farmer's field

An experiment was conducted at the FSRD Site, Hatgobindapur, Faridpur under the AEZ 12 during the rabi season 2016-17 to find out the optimum irrigation frequency for potential yield of winter onion. There were four irrigations treatments viz., 2-irrigations each at just after planting and 25 DAT (I_2 or Farmer`s practice), 3-irrigations each at just after planting and 25 and 45 DAT (I_3), 4-irrigations each at just after planting and 25,45 and 65 DAT (I_4), 5-irrigations each at just after planting and 25,45,65 and 85 DAT(I_5) were placed in the sub plot and two onion varieties; i.e. BARI Piaz-1 (V_1) and BARI Piaz-4(V_2) were placed in the main plot. It was laid out in a Split plot design with three replications. Treatment $I_{5,}$ produced the highest bulb yield (15.10 t ha^{-1}) which was statistically identical to I_3 and $I_{4.}$ But the lowest yield 13.81 tha^{-1} was obtained in I_2. Between two varieties BARI Piaz-4 showed better performance (15.49 tha^{-1}). In case of interaction between irrigation and variety, BARI Piaz-4(V_2) produced the highest bulb yield (16.19 tha^{-1}) in combination with I_5 which was identical to V_2I_3 and $V_2I_{4.}$ In economic analysis, the highest gross margin (Tk. 126490 ha^{-1} and Tk. 121970 ha^{-1}) and the highest benefit cost and ration (2.30 and 2.90) were obtained from the treatments V_1I_3 and $V_1I_{5,}$ respectively.

Effect of planting time and harvesting period on the yield of garlic for jessore region

An experiment was conducted at RSRC BARI Magura to study the influence of planting time and period of harvesting on the yield of garlic during 2016-2017 at Jessore Region. The soils are, in general, moderately deep with clay loam in texture having PH 7.68. The two factor experiment was designed in Randomized Complete Block Design (RCB) with four replications. The treatments comprised of two planting times viz. 15 October and 15 November and three harvesting period viz. 130, 140 and 150 DAP, respectively. The test Varity was BARI Rashun 2. The highest yield (8.46 t/ha) was recorded from mid-October planting when harvested at 140 DAP. The lowest yield (2.55t/ha) was found from mid-November planting when harvested at 150 DAP.

Effect of rhizome cut on the yield of ginger

The experiment was conducted at Regional Spices Research Centre, Gazipur during April, 2016 to February, 2017. Five rhizome cut consisting of one bud viz., S_1=5±2g, S_2=10±2 g, S_3=15±2g, S_4=20±2 g and S_5=40±2 g were considered as treatment (seed rhizome) in this experiment. Each treatment was planted on two rows plot of 2.5 m x 1.0 m (2.5 m^2) followed by Randomized Complete Block Design with three replications. The inter row and intra row spacing were 50 cm and 25 cm, respectively. The rhizomes were planted on April 19, 2016 and the crop was harvested on February 2, 2017. The test Varity was BARI Ada-1. The lowest days (36 and 44.5) was recorded for 1st and 50% emergence when maximum weighed rhizome cut (40±2 g) was used as planting material. All the yield contributing attributes showed significant variations except number of primary rhizome. The highest plant height (53.87 cm), number of leaves (145), tillers (15.67) were recorded in S_4 (20±2 g).But primary rhizome (68.30 g) obtained from rhizome cut 40±2 gwas found the heavier which was identical to 20±2 g (65.33 g). Plants grown from 20±2g weighed rhizome cut yielded the heavier rhizome / clump (335.5 g) and highest yield (23.54 t/ha) followed by 40±2 g (322.5 g, 22.68 t/ha, respectively). The highest seed cost per hectare was calculated (TK 4,80,000/ha) in case of using 40±2 g weighed rhizome cut followed by 20±2 g (TK 2,40,000) per hectare). The highest gross return (TK 14, 12,400/ha) and net return (TK 9, 62,022/ha) was recorded in treatment S_4=20±2 g rhizome cut.

Effect of rhizome size and seedling age on yield of ginger

A field trial was carried out at Regional Spices Research Centre, BARI, Magura during 2015-2016 and 2016-2017 to standardize the suitable seed size and optimum seedling age for successful cultivation of ginger in Jessore Region. The soils are in general, moderately deep with clay loam in texture. The two factor experiment was laid out in Randomized Complete Block Design with three replications. The treatment consisted of three different seed size viz.15g, 25g and 35g and three different seedling age viz, 28, 35 and 42 days old. In case of individual effect, the highest yield (19.22 t/ha in 2015-16 and 14.98t/ha in 2016-17) was obtained from 35g seed size. Similarly, the highest yield (19.31 t/ha in 2015-16 and 15.60 t/ha in 2016-17) was obtained from crops grown with 42 days old seedling, on the other hand, in case of, combined effect the highest yield (24.43 t/ha in 2015-16 and 18.78 t/ha in 2016-17) was recorded from the treatment combination of 35g seed size with 42 days old ginger seedling.

Intercropping of ginger, turmeric, bilatidhonia and naga chilli under cinnamon and bay leaf orchard

The experiment was conducted at Regional Spices Research Center, BARI, Gazipur during December 2015 to January 2016 to assess the performance of ginger, turmeric, Bilatidhonia and Naga chilli under bay leaf and cinnamon orchard on agronomical and yield parameters. All crops performed better under cinnamon orchard than bay leaf orchard. Turmeric gave the highest yield (585.7g/plant, 38.5 t/ha) under cinnamon orchard. The maximum gross and net returns taka 11.08 and 9.59 lakh/ha, respectively, was achieved from ginger cultivation under cinnamon orchard but the highest BCR (8.02) was found from turmeric under cinnamon orchard.

Development of ginger production technology under soilless culture using fertigation technique in Bangladesh

The experiment was conducted at Spices Research Center, Bogra during 25 May 2016 to February 2017. The effect of soilless substractes on growth and yield of ginger were studied. The main objective of the study was to determine the most suitable growth substrate for cultivation of ginger using fertigation technique and to produce disease free seed rgizome for higher yield. The study was conducted under the side- netted rain shelter equipped with an irrigation system to supply fertilizer solution at a regulated time schedule. Seven combinations of ginger substrates were evaluated: 1) Coco-dust, 2) Sawdust 3) Rice bran, 4) 50% Coco-dust + 50% sawdust 5) 50% Sawdust+ 50% rice bran, 6) 50% Coco-dust+ 50% rice bran and 7) Sandy loam soil (control). The treatments were arranged in randomized complete block design (RCBD) with eight replications. Two polybag (plant) was used per treatment in each replication. The ginger plants were selected randomly and the rhizome were harvested 10 month after planting. Plants growth in 50% coco dust + 50% rice bran gave the best growth performance and yield compared to the other treatments. The height rhizome yield (436.0 g/ polybag) was found from T_6 (50% coco dust + 50% rice bran) and the lowest rhizome yield (266.0g/polybag) was obtained from plants grown in T_3 (100% rice bran) treatment.

Effect of seed rate and row spacing on year round leaf production of coriander

The experiment was conducted at spices research centre, Shibganj, Bogra during rabi season, 2016-17 to find out the appropriate seed rate and row spacing for year round leaf production of coriander. The experiment was laid out in RCB design with three replications. Three seed rate viz., 30 kg, 40 kg and 50 kg and four row spacing viz., 10 cm, 15 cm, 20 cm and broadcast were compared to achieve the objectives. The highest leaf yield (9.22 t/ha) was obtained from 15 cm row spacing and the lowest leaf yield was recorded from 20 cm (7.23 t/ha) row spacing and and broadcast sowing (7.26 t/ha). The highest leaf yield was recorded (8.74 t/ha) from 50 kg seed sowing which was identical to 40 kg seed (8.49 t/ha) sowing and the lowest leaf yield was recorded from 30 kg seed (6.49 t/ha) sowing. The highest leaf yield was found (10.52 t/ha) from 15 cm x 40 kg seed sowing which differed significantly from other treatments and the lowest leaf yield was recorded from 20 cm x 30 kg (6.14 t/ha), 10 cm x 30 kg (6.20 t/ha) and broadcast x 30 kg seed sowing (6.28 t/ha).

Effect of sowing date on yield and yield attributes of black cumin

The experiment was conducted at Spices Research Sub-Center, Lalmonirhat during October 2016 to April 2017 to find out the effect of sowing time on disease severity (foot rot), yield contributing characters and yield of black cumin. BARI Black Cumin-1 was used as the test variety. The experiment was laid out in randomized complete block design with three replications. Seven different sowing dates viz. 10 October, 20 October, 1 November, 10 November, 20 November, 1 December, and 10 December were evaluate. Significant differences regarding yield and yield attributes were observed among different sowing dates. The highest yield (1178 kg/ha) was found from 20 November sowing which was significantly higher than other sowing dates. The lowest yield (787.59 t/ha) was found from 10 October which was statistically similar to 10 December (787.66 t/ha) sowing. Significantly higher plant height, number of capsules/plant, number of seeds/capsule, less disease severity and yield along with better yield contributing characters were observed from the 20 November sowing. The highest foot rot disease infection (30.48%) was in 10 Oct sowing which was significantly higher than all other sowing dates. The lowest infection (9.67%) was in 10 December sowing which was statistically similar to 1 December and 20 November sowing but significantly lower than 1 November, 10 October and 20 October.

Effect of harvesting time for quality seed yield of fennel

A field experiment was conducted at Spices Research Sub-Centre, Faridpur during rabi season, 2016-17 to find out the proper harvesting stage of fennel both for chewing and seed purpose and to assure best quality fennel both for chewing and seed purpose. The experiment was laid out in a Randomized Complete Block Design with three replications. The seed of fennel variety BARI Mouri-2 was sown on 17 November in 2016, maintaining 40 cm x 10 cm spacing. The experiment comprised of seven harvesting stage viz. 30, 35, 40, 45, 50, 55, and 60 days after flowering. The results revealed that different treatments had significant effect on yield and quality attributes of fennel seed. The fennel umbels which were harvested at 35 days after flowering (DAF) were superior to rest of the harvesting stages and recorded maximum sensory scores and good for chewing quality fennel with seed yield of 1.32 t/ha. However, for obtaining maximum seed yield (1.82 t/ha) umbel/seed should be harvested/picked after 45 - 50 DAF.

Effect of seed rate and sowing method on seed yield of fennel

The research was carried out at the research field of Spices Research Sub-Centre, Faridpur during Rabi season, 2016-17 to determine the optimum seed rate and suitable sowing method for Fennel cultivation. The experimental field belongs to high land of Low Ganges River Floodplain (AEZ 12) with clay loam in texture having 7.6-8.1 soil p^H. The experiment was laid out in a Randomized Complete Block Design (factorial) with three replications. BARI Mouri-1 was used as a test crop. Four different seed rates viz., 6, 8, 10 and 12 kg seed/ha and two sowing methods viz., Broadcasting and Line sowing method were evaluated. The highest seed yield (1569 kg/ha) was recorded from the treatment combination of 10 kg seed/ha × line sowing method. The lowest seed yield (985.8 kg/ha) was recorded from 6 kg seed/ha × Broadcasting method.

Effect of planting date and plant spacing on yield and yield components of ajown (*Trachyspermum ammi* l.)

The experiment was conducted at Spices Research Sub-Centre Faridpur during rabi season, 2016-17 to find out the optimum planting time and plant spacing for maximizing seed yield of ajown. The experimental field belongs to high land of Low Ganges River Floodplain (AEZ 12) with clay loam in texture having 7.6-8.1 soil p^H. The experiment was laid out in RCB design with three replications. The advance line TC GAZ 001 was used as test crop. Three sowing time viz., 01 November, 15 November and 30 November and three plant spacing viz., 40 cm × 10 cm, 40 cm × 15 cm, 40 cm × 20 cm were compared to achieve the objectives. The highest seed yield (770.1 kg/ha) was recorded from treatment combination of crops grown on 15 November with 40 cm × 10 cm spacing, which was identical to 01 November with 40 cm ×10 cm spacing. The lowest seed yield (345.2 kg/ha) was recorded from crops grown on 30 November with 40 cm × 20 cm spacing.

Effect of grafting time and methods on success of plum propagation

The experiment was conducted at the Regional Spices Research Center, BARI, Gazipur during June 2015 to October 2016 to evaluate the effect of grafting time and methods of grafting in plum propagation. Three types of grafting viz. cleft, side and contact grafting was practiced in six times (Mid-March, Mid April, Mid-May, Mid-June, Mid-July and Mid-August) onto air layering plum rootstock of an un-fruiting line PD Gaz 004 and replicated for three times. BARI Alubokhara-1 was used as test crop. Significant variations on success and death of grafts, number of branches, leaves and shoot length of live graft were observed due to grafting type and time of grafting. Early (March) grafting showed better performance in respect to rapid bud break, shoot length, branching and leaves per live graft compared to late (August). Cleft and contact graft resulted more success than side grafting. The maximum 9.67 (out of 10) graft success with 86.67% establishment was obtained in April from cleft grafting but the maximum establishment 90% was obtained from contact grafting in May without any death of separated grafts. Contact or cleft grafting in March to June may be suggested for commercial grafting of plums in Bangladesh condition.

Effect of layering time and growth regulator on success of air layering in plum

The experiment was conducted at the Regional Spices Research Center, BARI, Gazipur, Bangladesh during June 2015 to October 2016 to evaluate the effect of growth regulator (IBA) and air layering time on plum propagation. Air layering was done in six times (Mid April, Mid-May, Mid-June, Mid-July, Mid-August and Mid-September) with seven levels of IBA concentration viz. (0, 1000, 2000, 3000, 4000, 5000 and 6000 ppm) on two plum varieties (BARI Alubokhara-1 and PD Gaz 004). Significant variations on rooting, establishment and death of layers were observed due to layering time, variety and IBA concentrations. The un-fruiting line PD Gaz 004 showed outstanding performance in rooting and survivability of layers over BARI Alubokhara-1. Poor rooting and lower establishment caused very high mortality of layers in BARI Alubokhara-1. Rooting and survivability, number of roots, length of roots and leaf production increased with the increasing levels of IBA concentration up to 4000 ppm. The maximum (10 out of 10) rooting success of layer with 100% establishment from PD Gaz 004 was obtained when layered with 3000 ppm IBA in June Month. In BARI Alubokhara-1, the highest rooting success (6.5), and establishment rate (60%) were recorded with 4000 ppm IBA concentration in June layering. June to August layering with 3000-4000 ppm IBA treatment found better for successful air layering for vegetative propagation of plums in Bangladesh.

Nutrient and Water Management

Effect of different levels of sulphur on growth and yield of onion

A field experiment was carried out at Spices Research Centre, Shibganj, Bogra during rabi season of 2016-2017 to evaluate the effect of different levels of S on growth and yield of onion. BARI Piaz-1 was used for the present study. Six levels of sulphur viz. 0, 15, 30, 45, 60 and 75 kg ha^{-1} were evaluated. Different levels of S significantly influenced plant height, number of leaves plant^{-1}, bulb diameter and total yield per hectare. The treatment T_4 (45 kg S ha^{-1}) gave the best results regarding plant height (50.33 cm), number of leaves plant^{-1} (7.8) at 90 DAT, bulb diameter (5.28 cm) and total yield (14.98 t ha^{-1}). The highest plant growth and yield parameters were obtained from 45 kg S ha^{-1} along with a blanket dose of 100 kg N, 50 kg P, 75 kg K, 4 kg Z, 1.5 kg B ha^{-1} and 5 t cow dung ha^{-1}. Lowest growth and bulb yield were recorded from control T_1 (0 kg S ha^{-1}) treatment. However, the highest the highest net return TK 281999.6 ha^{-1} and benefit cost ratio of 4.05 was obtained at the fertilizer treatment of T_4 (45 kg S ha^{-1}).

Yield potential of onion as influenced by nutrient management

The field experiment was conducted during rabi season of 2016-17 at the research field of Spices Research Centre, Shibganj, Bogra to determine the optimum dose of fertilizer for maximization of bulb yield of onion. Two different onion varieties i.e. BARI Piaz-1 and BARI Piaz-4 were compared at different levels of fertilizer practices i.e. T_1 (Absolute Control), T_2 (STB dose), T_3 (SRC dose), T_4 (STB + 15% extra of STB), T_5 (STB + 30% extra of STB), T_6 (STB + 45% extra of STB) and T_7 (Farmer's practice). All the treatments significantly influenced plant height, leaf length, number of leaves plant^{-1}, bulb diameter, marketable yield and total yield per hectare. BARI Piaz-4 from treatment T_5 (STB + 30% extra of STB) gave the best results with regard to plant height (53.53 cm), number of leaves plant^{-1} (6.06), bulb length (7.26 cm) and bulb diameter (5.54 cm), while BARI Piaz-1 gave the same results with regard to bulb diameter (5.54 cm) under the same fertilizer level which was statistically similar to T_7 (Farmer's practice) and T_5 (STB + 45% extra of STB). The highest bulb yield was obtained from BARI Piaz-4 from the treatment T_5: STB + 30% extra of STB (19.91 t/ha). But the highest gross return (Tk. 405600/ha), net return (Tk. 309956.038 /ha) and highest benefit cost ratio (4.24) was recorded from same fertilizer treatment with BARI Piaz-1. The lowest gross return (Tk. 209250/ha) and net return (Tk. 141310 /ha) was recorded from control treatment with BARI Piaz-1.

Response of Zinc on onion

The experiment was conducted at Regional Spices Research Centre, BARI, Magura during November, 2016 to March 2017 to determine the optimum dose of zinc sulphate for onion cultivation. The experiment was conducted in Randomized Complete Block Design (RCB) with three replications with four treatments viz. 0,2,4,6 kg Zinc/ha. BARI piaz- 4 used as a planting material. The results of the study revealed that application of Zn had significant impact on yield and yield attributes of onion. The maximum plant height, number of leaves/plant, neck diameter, bulb diameter, bulb length and bulb weight was recorded from the T_3 treatment (4 kg Zn/ha). The highest bulb yield 9.0 t/ha was obtained from T_3 (4 kg/ha) while the lowest yield 6.9 (t/ha) was obtained from control.

Determine the appropriate dose(s) of N, P and K on year round leaf production of coriander

The experiment was conducted at spices research centre, Shibganj, Bogra during rabi season of 2016-17 to find out the appropriate fertilizer dose for year round leaf production of coriander. The experiment was laid out in RCB design with three replications. Eleven fertilizer combinations comprising of three levels of each of N (0, 30 60 and 90 kg/ha), P (0, 15, 30 and 45 kg/ha) and K (0, 20, 30 and 40 kg/ha) were compared to achieve the objectives. Response of crop to N was more pronounced in comparison to P and K. The maximum seed yield (10.07 t/ha) was recorded in T_4 ($N_{60}P_{30}K_{30}$ kg/ha) treatment which was identical (10.07 t/ha) to T_5 ($N_{90}P_{30}K_{30}$ kg/ha). Application of N_{60} P_{30} K_{30} kg/ha along with a blanket dose of 3 ton cow dung/ha appeared as the best treatment for maximizing the leaf yield of coriander.

Nutrient management for aromatic ginger (*Kaempferia galangal*)

The field trial was carried out at RSRC, BARI, Magura during 2015-16 and 2016-17 to evaluate the response of aromatic ginger to chemical fertilizer and to find out the optimum dose of NPKS. The soils are, in general, moderately deep with clay loam in texture having pH 7.68. The trial was laid out in Randomized Complete Block Design (RCBD) with three replications. The treatments comprised of 14 combination of different rate of NPKS viz., $N_0P_{40}K_{80}S_{20}$kg/ha, $N_{50}P_{40}K_{80}S_{20}$kg/ha, $N_{100}P_{40}K_{80}S_{20}$kg/ha, $N_{150}P_{40}K_{80}S_{20}$kg/ha, $N_{200}P_{40}K_{80}S_{20}$kg/ha, $N_{150}P_0K_{80}S_{20}$kg/ha, $N_{150}P_{20}K_{80}S_{20}$kg/ha, T_8= $N_{150}P_{60}K_{80}S_{20}$kg/ha, $N_{150}P_{40}K_0S_{20}$kg/ha, $N_{150}P_{40}K_{40}S_{20}$kg/ha, $N_{150}P_{40}K_{120}S_{20}$kg/ha, $N_{150}P_{40}K_{80}S_0$ kg/ha, $N_{150}P_{40}K_{80}S_{30}$ kg/ha, $N_0P_0K_0S_0$ kg/ha (control). Initial nutrient status of the experimental area is taken. The crop was planted on 17 May 2015 an on 20 may 2016 and harvested on 20 February in 2016 and on 10 February in 2017. The highest yield (15.28 t/ha in 2015 and 13.40 t/ha in 2016) was recorded from the treatment N_{150} P_{40} K_{120} S_{20} kg t/ha while the lowest yield (6.11 t/ha in 2015 and 6.08 t/ha in 2016) was obtained from the absolute control.

Insect and Disease Management

Efficacy of entomopathogenic fungi for the management of onion thrips (*Thrips tabaci*) in onion

Different entomopathogenic fungi were evaluated in field trials at RSRC, BARI, Gazipur during robi season 2016-17 for the management of Onion thrips (*Thrips tabaci* L.) in onion. All the treatments were effective in reducing thrips infestation in onion crop. Among the evaluated insecticide and bio-pesticides, the treatment with spinosad (Success 2.5 SC) @ 1.2 ml/L of water was the best and recorded significantly lowest thrips population on this treatment. The next best treatment in order of their efficacy to control onion thrips was Beauveria Bassiana. The highest bulb yield (15.4 t/ha) was obtained from Spinosad (Success 2.5 SC) treated plot due to its better population reduction throughout the season followed by B. bassiana treated plot (14.13 t/ha).

Management of onion thrips (*Thrips tabaci*) using different bio-pesticides in seed onion

A field experiment was conducted at RSRC, Gazipur during rabi season 2015-2016 to evaluate some management options against thrips in seed onion. BARI Onion-1 was the test crop. Six treatments Viz., T_1 = Spraying of Azadirachtin (Bioneem plus 1EC) @ ml/L of water, T_2 = Spraying of Abamectin (Ecomec 1.8EC) @ 1ml/L of water , T_3 = Spraying of Spinosad (Success 2.5SC)@ 1.2ml/l of water, T_4 = Spraying of Spirotetramet (Movento 150 OD) @ 1ml/l of water, T_5= Farmer’s practice (Three spraying of Imidacloprid-Imitaf 20SL@ 1ml/L of water) including T_6= Untreated controlwere evaluated. The maximum population reduction was obtained from Imidacloprid (Imitaf 20SL@ 1ml/L) of water treatment (89.90% adult and 83.42% larvae population after third spray) over control. Spirotetramet was the second best that reduced 83% adult and 79% larvae after third spray. The highest seed yield (450.4 kg/ha) was obtained from the treatment Imidacloprid (Imitaf 20SL@ 1ml/L) which was of water followed by Spirotetramet (1ml/l of water) treatment (435.6 kg/ha) and .

Evaluation of onion genotypes against thrips and iris yellow spot virus

The field experiment was conducted at SRC, Bogra during Rabi season of 2016-17 to test the performance of different onion genotypes against thrips and iris yellow spot virus. Eleven different onion genotypes (ONO252, ONO254, ONO263, ONO277, ONO278, ONO280, ONO281, ONO282, ONO284, ONO285 and ONO332) along with BARI Piaz-1, 2, 3, 4 and 5 were evaluated against thrips and iris yellow spot virus. Out of eleven genotypes, ONO332 and ONO278 recorded less than 8.50 thrips per plant and lowest iris yellow spot virus (2.40 and 5.47 per plant) with higher bulb yield (13.93 and 12.24 t/ha) were characterized as highly resistant. Genotype ONO254 recorded more than 16.90 thrips per plant and highest iris yellow spot virus (16.60 per plant) with lowest bulb yield (4.28 t/ha) were grouped into highly highly susceptible.

Role of border crop for the management of thrips of onion

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2016-17 to find out the effect of border crop for the management of thrips and the activity of natural enemy of onion. BARI Piaz-1 was used as test crop for this trial. Among different treatments, it was found that onion crop bordered by two rows of maize with two interventions of spray (first spray with Azadirachtin @ 1 ml per litre at 7 WAT and second spray with Diafenthiuron @ 1 ml per litre at 9 WAT) recorded lower thrips (3.98 thrips/plant) population with higher bulb yield (18.06 t/ha) and found significantly superior to all other treatments and farmers practice. The highest thrips population reduction (70.08%) over untreated control was also recorded fron the crop bordered by two rows of maize + Azadirachtin + Diafenthiuron treated plot. So, onion crop bordered by two rows of maize with two interventions of spray (first spray with Azadirachtin @ 1 ml per litre at 7 WAT and second spray with Diafenthiuron @ 1 ml per litre at 9 WAT) may be recommended for effective management of thrips in onion.

Efficacy of bio-rational insecticides against thrips in onion

The field experiment was conducted at SRC, Bogra during Rabi season of 2016-17 to evaluate the efficacy of different bio-rational insecticides for the management of thrips in onion. Six treatments were replicated three times in randomized complete block design. BARI Piaz-1 was used as test crop for this trial. The treatments were T_1= Spraying of *Beauveria bassiana* @ 5g/litre of water; T_2= Spraying of *Metarhizium anisopliae* @ 4g/litre of water; T_3= Spraying of Spinosad (Success 2.5 SC) @ 1.2ml/litre of water; T_4= Farmers practice- Three spraying of Dimethoate (Tafgor 40EC) @ 1ml/litre of water ; T_5= Control (Water +Sticker i.e Trix @ 5ml/litre of water) and T_6= Absolute control. All the insecticides were significantly better than absolute control in reducing thrips population after every spray. It was evident from the study that significantly lowest (4.30 thrips/plant) thrips populations were recorded from bio-pesticide Spinosad treated plot followed by farmers practice (7.95 thrips/plant) and Beauveria bassiana (8.46 thrips/plant) at 4th day after 3rd spray. Maximum marginal benefit-cost ratio was also obtained from Spinosad treated plot (33.09) followed by farmers practice (30.62) and Beauveria bassiana (15.96). This study showed that bio-pesticide Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water three times at an interval of 10 days from the first appearance of thrips infestation may be recommended for the control of thrips in onion.

Population dynamics of chilli thrips and mite in relation to weather parameters

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during rabi season of 2016-17 to study the population dynamics of chilli thrips and mite in relation to weather parameters. BARI Morich-3 was used as test crop for this trial. The infestation of thrips and mite started from 1st week after sowing i.e. last week of August (35th standard week) and remained in field till to the crop maturity (4th week of April) in the range of 0.54 to 7.40 thrips/leaf and 0.17 to 6.55 mite/leaf. Thrips and mite attained first (5.60 thrips/leaf and 4.34 mite/leaf), second (5.04 thrips/leaf and 4.13 mite/leaf) and third as well as the highest peak (7.40 thrips/leaf and 6.55 mite/leaf) during 3rd week of November, 1st week of December and 3rd week of April, respectively. Thrips and mite population are positively correlated with average temperature whereas negatively correlated with relative humidity and average rainfall.

Efficacy of different coloured sticky traps against thrips of chilli

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2016-17 to study the color preference of *Scirtothrips dorsalis* in chilli. BARI Morich-3 was used as test crop for this trial. The treatments were T_1= Blue trap @40 trap/ha; T_2= Yellow trap @40 trap/ha; T_3= White trap @40 trap/ha; T_4= Green trap @40 trap/ha and T_5= Pink trap @40 trap/ha. Among the color traps used, at 35 days after installation (DAI) of trap blue color attracted highest (8.44 thrips/ sq. inch area of trap) number of S. dorsalis adults followed by white (5.43 thrips/ sq. inch area of trap), yellow (4.30 thrips/ sq. inch area of trap), green (3.52 thrips/ sq. inch area of trap) and pink (3.40 thrips/ sq. inch area of trap) color. Blue coloured sticky trap also attracted comparatively less number of beneficial insects and can be used for relative estimate of S. dorsalis population and also for monitoring and mass trapping as a component of IPM program.

Development of management approach against thrips-mite complex of chilli

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2016-17 to develop an integrated management approach against thrips-mite complex of chilli. The treatments were five including control. White sticky trap (40 traps/ha) + Spraying of Diafenthiuron (Pegasus 50SC)@ 1ml/litre + Spinosad (Success 2.5SC) 1.2ml/litre of water resulted the lowest thrips (0.84 thrips/leaf) and mite (0.96 mite/leaf) population with highest marginal benefit cost ratio of 17.06. The highest percentage of thrips (87.29%) and mite (87.37%) population reduction over control with maximum red ripe chilli yield (14.68 t/ha) was also obtained from White sticky trap + Diafenthiuron + Spinosad. Thrips and mite populations are negatively correlated with Chlorophyll Concentration Index of leaf. However, the lowest percentage of upward (19.05%) and downward leaf curl (15.02%) was also obtained from White sticky trap + Diafenthiuron + Spinosad treated plot followed by White sticky trap + Azadirachtin + Diafenthiuron (22.75% and 22.49%, respectively) while the highest percentage of upward (71.25%) and downward leaf curl (81.54%) was obtained from untreated control. So, installation of sticky white trap along with spraying of Diafenthiuron and Spinosad may be recommended for effective management of thrips-mite complex in chilli

Role of intercrops for the management of chilli pest

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during Rabi season of 2016-17 to know the effect of different intercrops for the management of chilli pests. BARI Morich-3 was used as test crop for this trial whereas unknown cultivar of carrot, BARI Tomato-9, BARI Chinabadam-8 and BARI Dhonia-1 were used as intercrop for this trial. Among the different intercrops tested, chilli intercropped with garlic and carrot performed well by recording lowest population of sucking pests, leaf curl index, larval population of *Helicoverpa armigera* and *Spodoptera litura* with fruit damage. Whereas, the highest pest population of aphids, thrips, mite, leaf curl index, larval population of *H. armigera* and *S. litura* with fruit damage was observed in sole chilli crop. Mean yield data revealed that, the treatment chilli intercropped with garlic recorded highest red ripe chilli yield of 11.90 t/ha and it was statistically similar to treatment, chilli + carrot (11.50 t/ha) whereas, intercrop yield was highest in chilli + tomato (22.80 t/ha) followed by chilli + carrot (12.05 t/ha) and chilli + garlic (7.30 t/ha). Among the different intercrops, the highest marginal benefit-cost ratio (22.73) was recorded from chilli + garlic, followed by chilli +coriander (21.89), chilli + carrot (21.15) and chilli + tomato (20.71) whereas chilli +groundnut intercrop recorded the lowest marginal benefit-cost ratio (9.47). Predators like coccinellids were found greatly distributed in the crop having different intercrops. Chilli intercropped with garlic and coriander supported good activity of the predators. It appeared that growing intercrops in between the main crop was found advantageous in the management of chilli pest complex besides yield benefits.

Survey and documentation of major insect pests and their natural enemies in ginger

A survey was conducted during 2016-17 at different crop growth stages of Ginger (*Zingiber officinale* Rosc.) at RSRC, BARI, Gazipur and Taragonj upazila of Rangpur district for documentation of major insect pests of ginger and their natural enemies. Incidence of major insect pests like rhizome fly (*Mimegralla coeruleifrons*), leaf roller (*Udaspes folus*) and grasshoppers were observed in surveyed area. The population of rhizome fly and grasshopper was available at all stages of crop growth. About 48.67% rhizome rot problem was recorded from farmers field at Taragonj upazila and 22.6% rhizome rot was recorded at RSRC, Gazipur Leaf roller infestation was higher during early vegetative phase (45-60 days after planting) and grand growth stage (100-120 days after planting). Different natural enemies were observed in surveyed area. Among them lady bird beetle, hobber fly and spiders were the mostly important.

Survey and documentation of major insect pests and their natural enemies in turmeric

A survey was conducted during 2016-17 at different crop growth stages of turmeric (*Curcuma longa*) at RSRC, BARI, Gazipur and some selected turmeric growing area of Bangladesh for documentation of major insect pests of turmeric and their natural enemies. Incidence of major insect pests like rhizome fly (*Mimegralla coeruleifrons*), shoot borer (*Conogethes punctiferalis*), leaf roller (*Udaspes folus*), thrips (*Panchaetothrips indicus*) and grasshoppers were observed in surveyed areas. The population of rhizome fly was available at all stages of crop growth. Different natural enemies were observed in surveyed area. Among them lady bird beetle, hobber fly, spiders, red ant and black ant were most important. However, most of the rhizomes that contained maggots of rhizome fly were rotten. Leaf roller or feeder infestation was predominant in early vegetative phase (45-60 days) and grand growth stage (100-120 days) of the crop.

Assessment of chlorophyll loss due to infestation of gall mite on bay leaf

The field experiment was conducted at Spices Research Centre, Shibganj, Bogra, Bangladesh during May 2017 to analyse the percent loss of chlorophyll a and b induced by *Aceria doctersi* and to assess the damage potential of gall mite within the leaf galls of *Cinnamomum tamala*. The highest chlorophyll a (8.26 milligram/gm) and chlorophyll b (2.31 milligram/gm) content was recorded from control sample containing no gall tissue and the lowest chlorophyll a (2.20 milligram/gm) and chlorophyll b (0.66 milligram/gm) content was recorded from the sample containing ≥50 gall /1gm leaf sample. Eriophyid mite galls were negatively correlated with chlorophyll a (r= -0.98245**) and chlorophyll b (r= -0.95525**) content of bay leaf.

Effect of fungicides in controlling bulb rot of onion

The experiment was conducted in sick plot at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during Rabi season of 2016-17 to find out the effective control measure of basal or bulb rot of Onion. Bulb of BARI Piaz 4 was used in this experiment. The experiment was laid out in Randomized Complete Block Design with three replications. The treatments were T_1= Healthy and fresh Bulb, T_2= Bulb treatment and soil drenching with Cabriotop (0.3%), T_3= Bulb treatment and soil drenching with Bavistin DF (0.25%), T_4= Bulb treatment and soil drenching with Folicur 430 SC (0.1%), T_5= Bulb treatment and soil drenching with Provax 200 WP (0.25%), T_6= Bulb treatment and soil drenching with Companion (0.2%), T_7= Bulb treatment and soil drenching with Amistar Top 325 SC (0.1%) and T_8= Control. The lowest emergence (81.94%) of seedling was recorded in control plots and the highest emergence (97.76%) was recorded in Bulb treatment and soil drenching with Amistar Top 325 SC. The lowest bulb rot incidence (7.48%) and highest disease reduction over control (77.20%) was obtained from Bulb treatment and soil drenching with Amistar Top 325 SC which was statistically dissimilar to all other treatments. The highest bulb rot incidence (32.81%) was obtained from untreated control plots which was followed by Healthy and fresh Bulb (30.89%). The highest number of capsules per umbel (392.59), number of seeds per capsule (5.32), seed yield per plant (6.97 g) and yield (755.98 kg/ha) were obtained from Bulb treatment and soil drenching with Amistar Top 325 SC and the lowest of these parameters were obtained from untreated control.

Screening of garlic lines/variety against stemphylium leaf blight disease

The study was conducted at Spices Research Center, Bogra during rabi season of 2015-16 and 2016-17 to find out the resistance source of garlic against stemphylium blight disease. The land was medium high and the soil was clay loam in texture. The experiment was laid out in Randomized Complete Block Design with three replications. A total of fifteen (15) different garlic lines/variety (GC001, GC005, GC0012, GC0013, GC0017,Gc018, GC0027, GC0028, GC0029, GC0030, GC0031, GC0035, GC0038 and GC0040) and a susceptible variety BARI Rashun-1 as check were used in this experiment. Among these lines, thirteen lines including BARI Rashun-1 were found to be moderately susceptible and one line (GC0031) showed susceptible to stemphylium blight disease during 2015-16. During 2016-17, all the garlic lines/variety were found to be moderately susceptible to stemphylium blight disease. No resistant varieties/lines were found in this study in both the year. The highest yield (6.27 t/ha) was obtained from GC0027 and GC0028 in 2015-16 while it was highest from GC017 (7.37 t/ha) in 2016-17 which was identical to GC0027 (7.02 t/ha) and GC0028 (6.94 t/ha).

Effect of fungicide(s) in controlling stemphylium blight disease of garlic

The experiment was conducted at Spices Research Center, Shibganj, Bogra during 2015-16 & 2016-17 to find out the effective fungicide(s) in controlling Stemphylium blight disease of garlic. The land was medium high and the soil was clay loam in texture. The experiment was laid out in Randomized Complete Block Design with three replications. BARI Rashun-1 was used for this experiment. Eight fungicides namely Nativo 75WG, Amister Top 325 SC, Deconil 500 SC, Cabritop, Secure 600 WG, Protect 52.2WP, Tared 280 SC, Rovral 50WP along with control (untreated) were included as treatment in this study. The lowest disease severity (PDI value: 19.07) was recorded from Nativo in 2015-16 while it was lowest from Amister Top (PDI value : 19.62) in 2016-17. The highest percent efficacy of disease control (64.83) was recorded from Nativo in 2015-16 while it was highest from Amister Top (64.13) in 2016-17. The highest yield (8.37 t/ha) was obtained from Nativo in 2015-16 while it was highest (8.78 t/ha) was recorded from Amister Top sprayed plot in 2016-17. The lowest yield (4.03 t/ha in 2015-16 and 4.50t/ha in 2016-17) was recorded in control plots.

Screening of ginger lines/variety against rhizome rot disease complex

The trial was conducted at Spices Research Center, BARI Shibganj, Bogra during 2015-16 and 2016-17 to find out the resistant/tolerant lines of ginger against rhizome rot disease complex in sick plot. The land was medium high and the soil was sandy loam in texture. The experiment was laid out in a Randomized Complete Block Design with three replications. A total of twenty two (22) lines of ginger (G001, G003, G004, G0010, G0011, G0020, G0021, G0022, G0023, G0024, G0025, G0026, G0027, G0028, G0029, G0030, G0031, G0032, G0033, G0034, G0035, G0036) and a susceptible variety BARI Ada-1 as check were used in this experiment. Among these lines, one line, G0035 showed moderately resistant in both the year, three lines viz., G003, G031 and G032 showed highly susceptible in 2016-17, two lines viz., G0026 and G0027 showed moderately susceptible in both the year and eighteen (18) lines/variety showed susceptible against rhizome rot disease complex. The highest yield (14.57 t/ha in 2015-16 and 14.88 t/ha in 2016-17) was obtained from G0035 and the lowest yield (5.28 t/ha in 2015-16 and 5.44 t/ha in 2016-17) was obtained from.G003.

Management of foot and root rot disease of fenugreek

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during *Rabi* season of 2016-17 to find out the suitable control measures for foot and root rot disease of Fenugreek. BARI Methi-2 was used in experiment. The treatments were T_1= Seed treatment and soil drenching with Garlic extract (1:5), T_2= Seed treatment and soil drenching with Neem leaf extract (1:5), T_3= Seed treatment and soil drenching with Henna leaf extract (1:5), T_4= Seed treatment and soil drenching with Turmeric powder (0.5%), T_5= Seed treatment and soil drenching with Bavistin (0.25%), T_6= Seed treatment and soil drenching with Cabriotop (0.3%), T_7= Seed treatment and soil drenching with Provax 200 WP (0.25%) and T_8= Control. The lowest radial mycelial growth (4.29 mm) was found in Provax 200 WP (0.25%) treated plate followed by Bavistin (0.25%) and Cabriotop (0.3%), and the highest radial mycelial growth (52.18 mm) was obtained from untreated control followed by Garlic extract (50.84 mm) and Neem extract (47.18 mm) at 7 DAI. Similar trends were observed for Radial mycelial growth at 14 DAI. Foot and root rot incidence of fenugreek under different treatments ranged from 7.67 - 33.89%, while the lowest incidence was observed in Seed treatment and soil drenching with Provax 200 WP (0.25%) and the highest incidence was observed in untreated control which was followed by seed treatment and soil drenching with Garlic extract (1:5). Seed treatment and soil drenching with Provax 200 WP (0.25%) gave the highest seed yield (2.53 t/ha) which was followed by seed treatment and soil drenching with Cabriotop (0.3%) and seed treatment and soil drenching with Bavistin (0.25%), and the lowest seed yield (1.91 t/ha) was recorded in control.

Effect of fungicides in controlling alternaria leaf and umbel blight of fennel

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during Rabi season of 2016-17 to find out the effective fungicides in controlling Alternaria leaf and umbel blight of Fennel. BARI Mouri-1 was used in the experiment. The treatments were T_1= Rovral 50 WP (0.2%), T_2= Companion (0.2%), T_3= Nativo (0.1%), T_4= Secure 600 WG (0.15%), T_5= Score (0.1%), T_6= Cabriotop (0.3%), T_7= Amistar Top 325 SC (0.1%) and T_8= Control (Untreated). Alternaria leaf and umbel blight incidence of Fennel under different treatments varied from 28.34 - 65.95%, while the lowest incidence was recorded in Rovral 50 WP sprayed plots which was statistically identical to Secure 600 WG and Amistar Top 325 SC sprayed plots, and the highest incidence was obtained from Control plot. Rovral 50 WP gave the highest number of seeds/plant (16,197.00), weight of seeds/plant (27.47 g) and seed yield (1.68 t/ha) which were followed by Secure 600 WG and Amistar Top 325 SC sprayed plots, and the lowest of these parameters were recorded in Control.

Management of foot and root rot disease of fennel

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra, Bangladesh during *Rabi* season of 2016-17 to find out the suitable control measures in controlling foot and root rot disease of Fennel. BARI Mouri-1 was used in the experiment. The treatments were T_1= Seed treatment and soil drenching with Turmeric powder (0.5%), T_2= Poultry refuse (3.5 t/ha) (Soil amendment before 3 weeks of seed sowing), T_3= Seed treatment and soil drenching with Bavistin (0.25%), T_4= Seed treatment and soil drenching with Cabriotop (0.3%), T_5= Seed treatment and soil drenching with Provax 200 WP (0.25%), T_6= Seed treatment and soil drenching with Iminant Pro (0.1%) and T_7= Control. Foot and root rot incidence of Fennel under different treatments ranged from 9.95 - 33.88%, while the lowest incidence was observed in Seed treatment and soil drenching with Provax 200 WP (0.25%) and the highest incidence was observed in untreated control. Seed treatment and soil drenching with Provax 200 WP (0.25%) gave the highest number of seeds per plant (12,268.00), weight of seeds per plant (25.74 g) and seed yield (1.95 t/ha) which was followed by seed treatment and soil drenching with Cabriotop (0.3%) and seed treatment and soil drenching with Bavistin (0.25%), and the lowest of these parameters were recorded in Control plots.

Effect of fungicide(s) in controlling alternaria blight of cumin

The experiment was conducted at Spices Research Center, BARI, Shibganj, Bogra, during Rabi season of 2015-16 and 2016-17 to find out the effect of fungicide(s) for the management of Alternaria blight of cumin. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a Randomized Complete Block Design with three replications. Eight fungicides namely Amister Top 325, Cabriotop, Companion, Trizole 75WG, Protect 52.2WP, Rovral 50 WP, Secure 600 WG, Deconil 500 SC along with control (untreated) were included as treatment in this study. The fungicides were sprayed 6 times at an interval of 8 days from disease initiation (pre-flowering stage). The lowest disease severity (6.24 & 7.14 PDI in 2015-16 & 2016-17, respectively) was recorded in Amister Top sprayed plots and the highest disease severity (78.81 & 51.33 PDI in 2015-16 & 2016-17, respectively) was recorded in control plots. The highest percent efficacy of disease control (91.7% & 85.93% in 2015-16 & 2016-17, respectively) was recorded from Amister Top sprayed plots and the lowest was recorded in Rovral sprayed plots (48.06%) in 2015-16 and Trizole sprayed plots in 2016-17. The highest yield (467.60 kg/ha & 570.30 kg/ha in 2015-16 & 2016-17, respectively) was obtained from Amister Top sprayed plots. In 2015-16, no yield was obtained from control plot however the lowest yield (60.03 kg/ha) was recorded from Trizole sprayed plot. In 2016-17, the lowest yield (85.03 kg/ha) was recorded from control plot.

Determination of spray schedule of fungicide(s) in controlling alternaria blight disease of cumin

The experiment was conducted at Spices Research Center, BARI, Shibganj, Bogra, during rabi season of 2016-17 to determine the spray schedule of fungicide(s) in controlling alternaria blight disease of cumin. The land was medium high and the soil was clay loam in texture. The experiment was laid out in Randomized Complete Bock Design (factorial) with three replications. Three sprays schedule viz. S_1: Spray at 7 days intervals, S_2: Spray at 10 days intervals, S_3: Spray at 13days intervals and three fungicides viz. F_1: Amister Top 325 SC (Azoxystrobin + Difenoconazole) @ 0.1%, F_2: Deconil 500

SC (Chlorthalonil) @ 0.15% & F_3: Alternate spray of Amister Top and Deconil were evaluated in this experiment. The lowest disease severity (PDI value13.25) was recorded from Amister Top @ 0.1% sprayed plot at 7 days interval and the highest disease severity (PDI value 44.17) was recorded from Deconil @ 0.15% sprayed plot at 10 days interval. The highest yield (471.60 kg/ha) was obtained from Amister Top @ 0.1% sprayed plot at 7 days interval and the lowest yield (161.7 kg/ha) was obtained from Deconil @ 0.15% sprayed plot at 13 days interval.

Screening of Indian bay leaf lines against leaf spot and grey leaf spot disease

The trial was conducted at Spices Research Center, BARI Shibganj, Bogra during 2014-15 to 2016-17 to find out the resistant/tolerant lines of Indian bay leaf against leaf spot and grey leaf spot diseases. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a Randomized Complete Block Design with three replications. A total of four lines of Indian bay leaf (CTB001, CTB002, CTB003 and CTB004) were evaluated in this experiment. In 2014-15, among these lines, CTB003 showed resistant against leaf spot and grey leaf spot disease, two lines viz., CTB001 and CTB004 showed moderately susceptible against leaf spot and grey leaf spot disease and the line CTB002 showed highly susceptible against these diseases. The highest fresh yield (35.02 kg/plant) was obtained from CTB004 followed by CTB003 (31.52 kg/plant). In 2015-16 and 2016-17, among these lines, CTB003 showed resistant against leaf spot and grey leaf spot disease, CTB001 and CTB004 showed susceptible against leaf spot and grey leaf spot disease and the line CTB002 showed highly susceptible against leaf spot disease whereas susceptible to grey leaf spot disease. The highest fresh yield (36.03 kg/plant in 2015-16) was obtained from CTB004 followed by CTB003 (34.07 kg/plant) but the result was statistically identical. But in 2016-17, the highest fresh yield (39.91 kg/plant) was recorded from CTB003 which was followed by CTB004 (37.03 kg/plant).

Post Harvest Technology

Determination of capsaicin in BARI varieties of chilli

The aim of the present study was to determine the content of capsaicin in three varieties of chilli grown in Regional Spices Research Centre, BARI without the need for a derivatization step and calculate their pungency in Scoville heat units (SHU). The investigated samples consisted of BARI chilli-1, 2 and 3. Extraction of capsaicin was done using methanol as solvent, while Ultra-Fast Liquid Chromatography (UFLC) was used for separation, identification and quantitation of the components. “BARI chilli-2” had the highest concentration of capsaicin (4.989±0.182 mg/g) and pungency level (79812.88SHU), whereas, “BARI chilli-1” had the lowest concentration (1.562±0.132mg/g) and pungency level (24991.05SHU).

Effect of seed extraction method on the seed quality of chilli

The research was carried out at Spices Research Centre, Shibganj, Bogra during rabi to kharif-1 season, 2015-16 and 2016-17 to identify suitable seed extraction method of chilli and to assess the effect of seed extraction method on the seed quality of chilli. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a Complete Randomized Design (CRD) with three replications. BARI Morich-3 was used as the test crop. The number of treatments were 12. The treatments were categorized in three different seed extraction methods viz i) dry method ($T_{1,}$ sun drying of red ripe fruit), ii) manual seed extraction method ($T_{2,}$ extraction of seed by hand) and iii) wet method (T_3 - $T_{12,}$ fermentation of red ripe fruit for 1-10 days in water). For extracting a large quantity of seeds, it was found that the wet method was easier than the dry method or manual seed extraction method. The largest amount of seed was extracted from the treatment T_2 (112.0 g/kg fruit in 2015-16 and 76 g/kg fruit in 2016-17) which was identical to T_1 (70 g/kg fruit in 2016-17), T_{12} (110.1g/kg fruit in 2015-16 and 62 g/kg fruit in 2016-17), T_{11} (108.8.0g/kg fruit in 2015-16 and 62 g/kg fruit in 2016-17), T_{10} (108.3g/kg fruit in 2015-16), T_9 (100.5g/kg fruit in 2015-16), T_8 (98.2g/kg fruit in 2015-16), T_7 (95.5g/kg fruit in 2015-16) and T_6 (94.9g/kg fruit in 2015-16. The smallest amount of seed was extracted from T_3 (26.65g/kg fruit in 2015-16 and 0 g/kg fruit in 2016-17) treatment. On the other hand, The higher percentage of seed germination was recorded from the treatment T_3 (96% in 2015-16) and T_4 (97% in 2016-17) which was identical to T_5 (90% in 2015-17 and 95% in 2016-17), T_1(87% in 2015-17 and 90% in 2016-17) and T_2 (85% in 2015-17 and 94% in 2016-17). The lower percentage of seed germination was recorded from the treatment T_{12} (1% in 2015-17 and 51% in 2016-17). Also the higher percentage of seedling emergence was recorded from the treatment T_2 (67% in 2015-17 and 43% in 2016-17) which was identical to T_1 (63% in 2015-17 and 82% in 2016-17), T_3 (61% in 2016-17) and T_4 (58% in 2015-17 and 81% in 2016-17) followed by T_5 (57% in 2015-17 and 80% in 2016-17) and T_6 (50% in 2015-17 and 80% in 2016-17). The lower percentage of seedling emergence was recorded from the treatment T_{12} (0% in 2015-17 and 24% in 2016-17) and T_{11} (0% in 2015-17). It was recorded that the germination rate was quicker for the wet method compared to dry method or manual seed extraction method. It was concluded that among the treatments of wet extraction methods the treatment T_6 was better. That means seed should be fermented for 4 days. But the fermentation period can be reduced up to 3 days (T_5) depending on the firmness of pericarp of the fermented fruit. In case of small amount of fruit, it is better to use the manual seed extraction method (T_2) or dry method (T_1).

Effect of different pre-treatments on quality attributes of dehydrated green chilli powder

A study was conducted to prepare green chilli powder using low cost processing technique and to study the physiochemical characteristics of green chilli powder. Chili were treated with 200, 1000, 2000 and 3000 mg. $Kg^{-}1$ $Na_2S_2O_5$ solution for 30, 60 and 120 min. followed by 3 min blanching and dried in 65^0C. 1% $CaCl_2$ solution and 2% ascorbic acid solution were used for two treatments. Furthermore drying temperature 50^0C was introduced for two samples. The results revealed that the SO_2 content of soaked chilli increased with increasing $Na_2S_2O_5$ concentration and soaking time. Thermal treatments from blanching and drying reduced the SO_2 residues in blanched and dried chilli. The nutritional quality in terms of proximate composition protein, fat, moisture, total carotene, vitamin C, ash and minerals contents of green chilli powder were also assessed. The results showed that the nutritional quality in all the samples of green chilli powder was almost higher than that of red chilli powder. Nontreated sample showed higher mineral content than treated sample. After conducting organoleptic taste test of different treated and untreated green chilli powder packed in HDPE bag/plastic bouem and stored at RT, the results for colour, smell, pungency and overall acceptability of 16 samples showed that pretreated with 1000ppm $Na_2S_2O_5$ solution for two hr. + blanched 3min + dried in 65^0C (S_1) and Sliced green chilli+ 3 min blanched and dried in 65^0C (S_3) powder found better among other treated and untreated sample. In order to determine the suitability of that powder in a curry, it was decided to conduct organoleptic taste test of beef curry using above 2 samples (T_7 and T_{15}) with ripe chilli powder (collected from renowned company). The results showed that all the samples are statistically identical in respect of colour, flavour, pungency, taste and overall acceptability though there are little bit difference in scoring among each attributes. It is concluded that the above two samples (T_7 and T_{15}) are undoubtedly use instead of red chilli powder.

Processing of annatto seeds and its potentiality of use as dye in food

The experiment was concerned to determine the processing technique of annatto capsule (AC) and to assess the overall acceptability as natural dye for food. Long shape AC showed better result compared to round shape. Mid February harvesting time gave good colour compared to March. Processing was done in two ways; with seed and without seed. Water and fats were used as solvent for processing the annatto seed. The precipitation from water extraction, dehydrated in two different ways: firstly, in oven drying at variable temperature (60 and 80^0 C) and secondly, by sun drying (35-40^0 C). Drying time for oven were around 72- 96 hr and sun drying 190 hr. For conducting organoleptic taste test annatto dye of sun and oven dried with and without seed were evaluated. The final products of sun and oven dried (without seed) showed better result compared to others. The dehydrated annatto powder (without seed) packed in plastic pot and stored at room temperature (RT) and refrigerated temperature (RFT). Both the products at RT and RFT were found better. The results for colour, flavour and overall acceptability of different samples showed that oven dried powder and fat extracted annatto oil found best among other treated (processed annatto powder with seed) sample. In order to determine the suitability of annatto powder and annatto oil, it was decided to conduct organoleptic taste test of Jarda polao compared to purchase colour (from market). These are S_1: Annatto oil (Extraction of annatto dye in fat), sample no. S_2: Purchased orange colour (from market, control), sample no. S_3: was prepared seed free annatto extraction in water followed by dehydration. It is concluded that sample S_1 and S_3 are undoubtedly the better samples (among the samples tasted) since these samples secured the better scores for almost all quality attributes and were equally acceptable and statistically insignificance.

Socio-economic Study

Marketing and value chain analysis of dry chilli: a study in selected areas of Bangladesh

The study was undertaken to determine marketing system, marketing cost, margin, efficiencies and to examine the value chain aiming to determine the value addition of dry chilli in different steps of marketing channel. Primary data were used for this study. Primary data were collected from Bogra, Sirajganj and Comilla districts depending upon the concentration of production and commercially marketing of chilli; and consuming area Dhaka, Rajshahi and Chittagong. Data were analyzed using marketing margin, profit, efficiency ratio, and value addition. Five major marketing channels were identified for domestic produced dry chilli marketing. Channel-3(Farmer→Trader→Commission agent→Retailer→Consumer) was the most important supply chain through which 24% domestic produced chilli reaches to consumers. Per quintal marketing cost of chilli was estimated from Tk 101.88 to 3921.15 and marketing margin Tk 777.00 to 12564, respectively for different intermediaries. Marketing margin and profit were the highest in retailer for non processed chilli and those were the highest with processed chilli in processing industry than those of other intermediaries. Out of five marketing channel, Channel-2 was more efficient than those of other channels. Eight actors like; farmer, local trader, trader, commission agent, wholesaler, processing industry, distributor, retailer and consumer were identified who were involved in the chilli value chain systems. The study revealed that farmer added the highest amount of value Tk 1790.00 per quintal in non processed chilli followed by retailers (Tk 1339.00), Trader (Tk 1244.00), wholesalers (Tk 1035.00) and local trader (Tk 777.00), respectively. In the case of processed chilli, processing industry added the highest amount of value and it was Tk.12564 per quintal. Thirteen marketing problem were identified, among them price fluctuation, higher transport cost and lack of loan facilities were the major and common problem for most kinds of intermediaries involved in chilli marketing in Bangladesh. It is therefore, recommended that loan facilities should be provided to the intermediaries and price fluctuation should be kept in reasonable limit by the government intervention. Natural gas and frequent supply of electricity should be ensured to chilli processing industries for continuous production of processed chilli Technologies should be developed for identification and removal of alpha toxin and heavy metal for enhancing export.

6 VEGETABLE CROPS

Eggplant

Varietal improvement

Genetic diversity of eggplant germplasm during winter season

The study was conducted at the experimental field of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2016-17 to assess the extent of genetic diversity among 23 eggplant germplasm. The collected germplasm originating from different local and exotic sources were subjected to cluster analysis. The germplasm were constellated into five distinct groups with the range of 1 germplasm in cluster I to 9 germplasm in cluster III. The inter-cluster distance in all cases was larger than the intra-cluster distance. Maximum inter-cluster distance (33.05) was observed between germplasm of cluster I and V followed by cluster I and IV (29.00) and minimum was found between germplasm of cluster IV and V (4.84). The highest intra cluster value (0.953) was observed in cluster V. Mean performance of different clusters revealed that Cluster I recorded the lowest mean for days to 1st harvest (113.00 days), number of marketable fruit (19.00), fruit length (12.00 cm) and highest mean for average fruit weight (246.84g), fruit diameter (8.50cm), plant height at 1st harvest (90.00 cm), plant height at last harvest (135.0cm), fruit yield (60.9t/ha).Therefore, inbreds belong to cluster I, cluster IV and cluster V would be given higher priority for crossing in future eggplant hybridization programme.

Evaluation of eggplant germplasm for summer season at Jamalpur region

The experiment was conducted with eight open pollinated eggplant germplasm viz., SM Jam 001, SM Jam 005, SM Jam 007, SM Jam 008, SM Jam 009, SM Jam 010, SM Jam 011 and SM Jam 013 at RARS, Jamalpur during the summer season of 2016 to find out good quality summer type variety. The highest (95) number of fruits per plant was noted from the line SM Jam 001 and the lowest (8) number of fruits per plant was noted form the line SM Jam 010. Maximum yield (22.12 t/ha) was produced by the line SM Jam 008 and minimum yield (12.32t/ha) was produced by the line SM Jam 007. Considering earliness, higher yield and tolerance to pest and disease the lines SM Jam 001, SM Jam 008, SM Jam 010, SM Jam 011 and SM Jam 013 were found superior and may be selected for PYT.

Evaluation of eggplant germplasm for winter season at Jamalpur region

The experiment was conducted with twelve open pollinated eggplant germplasm viz., SM Jam 001, SM Jam 004, SM Jam 005, SM Jam 007, SM Jam 008, SM Jam 009, SM Jam 010, SM Jam 011, SM Jam 012, SM Jam 013, SM Jam014 and SM Jam 015 at Jamalpur during the winter season of 2016-17. The highest (81) number of fruits per plant was noted from the line SM Jam 009 and the lowest (8.4) number of fruits per plant was noted from the line SM Jam 004. Maximum yield (27.25 t/ha) was produced by the line SM Jam 015 and minimum yield (13.2 t/ha) was produced by the line SM Jam 007. Considering earliness, higher yield and tolerance to pest and disease the lines SM Jam 015, SM Jam 013, SM Jam 011, SM Jam 012, SM Jam 09 and SM Jam 010 were found superior and may be selected for PYT.

Screening of BARI released eggplant varieties against salinity

A pot experiment was conducted at the research field of Olericulture Division, Horticulture Research Center, BARI, Joydebpur, Gazipur during the rabi season of 2016-17 to screen out salt tolerant eggplant variety(ies). Fifteen eggplant varieties viz.; BARI Begun-1 (BB1), BARI Begun-4 (BB4), BARI Begun-5 (BB5), BARI Begun-6 (BB6), BARI Begun-7 (BB7), BARI Begun-8 (BB8), BARI Begun-9 (BB9), BARI Begun-10 (BB10), BARI Hybrid Begun-2 (BHB2), BARI Hybrid Begun-3 (BHB3), BARI Hybrid Begun-4 (BHB4), BARI Bt Begun-1 (Bt1), BARI Bt Begun-2 (Bt2), BARI Bt Begun-3 (Bt3) and BARI Bt Begun-4 (Bt4) were included in this study. After transplanting into 15 L pots, the plants were exposed to 0 (control) and 8 dS/m salinity stresses and continued upto final harvest. The results revealed that soil salinity markedly reduced plant height, number of leaves/plant, fresh weight of plants and roots, number of fruits/plant, individual fruit weight and fruit yield/plant in all eggplant varieties. The minimum reduction of fruits/plant was obtained in BB9 and maximum in BB1, BB5 and Bt4. The lowest reduction of individual fruit weight was obtained in BHB4 followed by Bt1 and BB10, while the highest reduction in BHB2. In control condition, the highest fruit yield was recorded from BB5 followed by Bt2, whereas; in 8 dS/m salinity stress, the highest yield was recorded from BHB4 followed by Bt2. However, due to salt stress, the reduction of fruit yield/plant was the lowest in BB9 and the highest in BB6 and BB5. From the current study it may stated that none of the eggplant varieties found to be tolerant to 8 dS/m salinity stress and therefore, the study may be repeated in the following year including more number of eggplant varieties/lines.

Preliminary yield trial of eggplant for winter

A study on the performance of fourteen eggplant lines/varieties was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the winter season of 2016-17 to develop high yielding fruit and shoot borer, bacterial wilt tolerant OP variety. The range of days to first harvest was 112.00 to 120.00 days, while the highest marketable fruit number per plant (36.66) was obtained by SM190 which was statistically similar with SM253B, SM284A, BARI Begun-4 (35.66) and the heaviest fruit was obtained from SM293 (132.260 g) which was statistically similar with SM2891 (129.97 g). In case of bacterial wilt, there was no incidence among the SM236C, SM253B, SM272, SM284C, SM289-1, SM291, SM291B, SM293, SM298. The significant highest yield (59.23 t/ha) was produced by SM289-1 followed by SM253B (56.63 t/ha), SM236C (53.38 t/ha), SM291B (53.12 t/ha), SM284C (52.08 t/ha), SM293 (51.52 t/ha), SM298 (50.65 t/ha) andSM269A (50.52 t/ha) while least was produced by SM190 (26.21 t/ha). Out of 13 advanced lines, eight lines produced more than 50 t/ha. Minimum infestation by BFSB was 6.81% was observed in SM284C, while the over all infestation (%) range was 6.81 to 13.78. The results of the present study revealed that considering earliness, higher yield, pest tolerance, fruit shape and colour, advanced lines viz., SM289-1, SM253B, SM236C, SM291B, SM284C, SM293, SM298 andSM269A were found promising, and may be put under trial for AYT in the next winter season.

Preliminary yield trial of eggplant lines at Ishurdi region

Performance of eleven eggplant germplasm out of thirty six collected from Ishurdi region were investigated at Regional Agricultural Research Station, Ishurdi, Pabna during Rabi season of 2016-17 to develop high yielding eggplant varieties. Early harvest (109 days) was done in SM Isd-027 while average fruit weight was ranged from 162-258 g. The longest fruit (23.73 cm) was harvested from SM Isd-027 and the shortest fruit (7.89 cm) from SM Isd-006. On the other hand, the widest fruit 9.20 cm) was obtained from SM Isd-010. Most of the germplasm gave satisfactory yield ranged 33.06-58.98 t/ha. However, the highest marketable yield (58.98 t/h) was recorded from SM Isd-028 and the lowest yield (33.06 t/ha) from SM Isd-006. Considering yield, colour and shape and taste, SM Isd-003, SM Isd-005, SM Isd-022, SM Isd-023, SM Isd-027 and SM Isd-028 were found promising. These lines may be included for AYT next year.

Advanced yield trial of eggplant lines for summer

A study on the performance of twelve eggplant lines with the variety BARI Begun-6, BARI Begun-8, BARI Begun-10 (check) were conducted at the experimental farm of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the summer season of 2016 to develop new OP summer varieties tolerant to eggplant fruit and shoot borer and bacterial wilt. The lines SM083D, SM222B, SM236A and SM259 took the minimum days to 1st harvest which were identical and was 90.67 days. The highest number of marketable fruit/plant (40.16.) was found in SM083D while the lowest number of fruit was produced by BARI Begun-6 (21.03). The highest average fruit weight was obtained from BARI Begun-6 (130.33g) followed by SM253B, SM191B and the lowest fruits weight/plant was observed in SM259 (58.43g). The longest fruit was recorded from BARI Begun-10 (22.0cm) followed by BARI Begun-8 while the shortest was from SM253B (5.73cm).The minimum fruit diameter was recorded from BARI Begun-6 (6.96cm) while the shortest was from SM259 (2.66cm). Zero percent bacterial wilt incidence was observed in SM191B, SM203, SM222B, SM232, SM236A, SM259, SM267, BARI Begun-8, BARI Begun-10. The highest fruit yield was recorded from SM083D (47.90 t) followed by SM222B (42.70 t), while the lowest was produced from SM233 (23.51 t). Minimum infestation by eggplant fruit and shoot borered was 7.67% was observed in SM269A followed by SM204 (8.48%) and maximum was observed SM233 (23.65%). Considering earliness, higher yield, pest and diseases tolerance, the lines SM083D, SM222B, SM232, SM259 and SM191B were found promising and may be recommended for RYT in next year.

Advanced yield trial of eggplant lines for winter

A study on the performance of seventeen selected advance eggplant lines with BARI Begun-4 was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the winter season of 2016-17 to observe the performance of the selected lines. The line SM083 took the minimum time (90 days) to first harvest and delayed harvesting line was SM181C (120 days). The line SM232A produced the maximum number of marketable fruit (38.86) and the minimum was (28.73) from SM254. The highest fruit weight (138.64g) was recorded from SM254 followed by SM081B, SM232 and the lowest fruit weight was from SM048. The line SM232B (22.93cm) produced the longest fruit while SM203 (9.60 cm) produced the shortest fruit. The highest diameter fruit was recorded from SM083H (9.23 cm), while the lowest was from SM222B (3.43cm). The fruit yield/ hectare was obtained from the line SM181B (56.76t) followed by SM232 (52.78t) while the lowest was recorded from SM048 (32.45t), SM203, SM222B and SM221B. The highest plant height at last harvest time was SM232 (110.60cm) and the lowest was from SM181C (86.60cm). Minimum infestation by eggplant fruit and shoot borer was observed in SM230 (10.05%) followed by SM254 (11.35%), SM232B (11.37) and the highest infestation was observed from SM048 (17.60%) followed by SM222B (16.53). Considering earliness, high yield and pest tolerance, the lines SM181B, SM232 and SM254 were found promising and may be recommended for RYT.

Regional yield trial of eggplant lines for summer

A study on the performance of four eggplant lines with BARI Begun-6, BARI Begun-8 (check) was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh during the summer season of 2016 to develop new OP varieties having tolerance to fruit and shoot borer and bacterial wilt. Except the line SM217A, all the lines and varieties took maximum (105.33-107.67) days to first harvesting which were identical, while SM217A took minimum days (101.67). The highest marketable fruit number/plant was recorded from the line SM206 (51.66), while the lowest identical number were recorded from SM021, SM 181A and BARI Begun-6. The maximum fruit weight was obtained from BARI Begun-6 (130.33g) followed by SM021, SM 181A and the lowest fruits weight/plant was observed from BARI Begun-8 (95.67g). The longest fruit was recorded from BARI Begun-8 (22.96cm) followed by SM17A while the shortest was from SM181A (4.80cm).The highest fruit yield (t/ha) was recorded from SM206 (58.49t) while others were produced identical lower yield (27.47-38.17 t/ha). At first harvest, the line SM021 showed the tallest height (86.66cm) followed by the others lines/variety while BARI Begun-6 showed the shortest height (7.33cm). At last harvest, the highest plant height was recorded from BARI Begun-8 while the lowest height was recorded from SM206 (106.0 cm). Maximum infestation by eggplant fruit and shoot borer was 18.52% which was observed in BARI Begun-8, while minimum infestation was observed in SM2066 (7.05%) and SM217A (8.48%). The infection of BW (Bacterial wilt) mortality was 11.33% and 10.66% from SM181A and BARI Begun-6, respectively. Considering earliness, higher yield, pest and diseases tolerance, the lines SM206 and SM217A were found superior. So these two lines may be repeated as RYT in next year.

Regional yield trial of eggplant lines for winter

Four advanced eggplant lines SM021, SM206, SM 216 and SM 217A including two check varieties BARI Begun-4 and BARI Begun-9 were evaluated at five locations viz., Joydebpur, Akbarpur, Hathazari, Rahmatpur, Jessore of BARI research stations, during winter season of 2016-17 to observe their yield and yield potentiality at different locations. On an average, the advanced line SM 021 possessed the highest number of marketable fruits (37.5) per plant and the highest yield was produced by SM 216 (50.93 t/ha) followed by SM 021 (40.54 t/ha), SM216 (44.22 t/ha) and may be repeated for further confirmation in next year.

Performance of eggplant hybrids for winter

Thirty one eggplant hybrids/varities ware evaluated at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the winter season of 20016-17 to develop high yielding fruit and shoot borer (BW) tolerant hybrids. The range of days to first harvest was 125.00 - 131.00 days, while the highest marketable fruit number per plant (48.80) was obtained by F_1 4 x233 and the heaviest fruit was obtained from the hybrid F_1 21x13 (187.60 g). In the case of (BW) infection at field level performance, there were zero percent incidence among 19 hybrids. The highest yield (73.84 t/ha) was produced by F_1 19 x216 followed by F_1 20 x203, F_1 220 x206 (65.13 t/ha), F_1 220 x221B (64.09 t/ha), F_1 5 x216, F_1 12 x217A (62.53 t/ha), F_1 1x216 (61.62 t/ha), F_1 5 x8, F_1 21 x13 (61.36 t/ha), F_1 20 x233 (60.97 t/ha), F_1 21 x221B (60.58 t/ha), while least was produced by F_1 191B x259 (30.66 t/ha). Minimum infestation by BFSB (5.53%) was observed in F_1 217A x216, while the over all infestation (%) range was 5.53-20.17. The results of the present study revealed that hybrids viz., F_1 19 x216, F_1 20 x203, F_1 220 x206, F_1 220 x221B, F_1 5 x216, F_1 12 x217A, F_1 1x216, F_1 5 x8, F_1 21 x13, F_1 20 x233, F_1 21 x221B were superior and may be put under trial for PYT in the next winter season.

Preliminary yield trial of eggplant hybrids for summer

The study on the performance of nine eggplant hybrids/ variety was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the summer season of 2016 to develop high yielding, tolerance to brinjal fruit and shoot borer and bacterial wilt F_1 eggplant varieties and suitable for summer season cultivation. The lines varied significantly ($P<0.05$) for their response to all characters. The hybrid F_1 14x216 took minimum 89.33 days to first harvest, while the highest marketable fruit number per plant (74.63) were obtained by F_1 14x233 and the heaviest fruit was obtained from the F_1 21x233 (101.57 g). There was no incidence bacterial wilt infection at field level performance among the 21 hybrids. The highest fruit yield (81.13 t/ha) was produced by F_1 14x233 followed by F_1 14x216 (65.08 t/ha), F_1 19x216 (54.49 t/ha), F_1 19x233 (52.76 t/ha), F_1 1x233 (51.14 t/ha), F_1 5x233 (49.63 t/ha), F_1 1x216 (47.03 t/ha), while the lowest was produced by F_1 5x203 (32.33 t/ha). Minimum infestation by BFSB was 4.56% was observed in F_1 5x8, while the infestation range was 4.56% -13.50%. The results of the present study revealed that seven hybrids viz., F_1 14x233, F_1 14x216, F_1 19x216, F_1 19x233, F_1 1x233, F_1 5x233, F_1 1x216 were found promising for earliness, high yield, BFSB and bacterial wilt tolerance, fruit shape, fruit colour and may be put under trial for AYT in the next year summer season.

Preliminary yield trial of eggplant hybrids for winter

The study was conducted with 29 eggplant F_1 lines/varieties at the experimental field of Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during winter season of 2016-17 to select high yielder F_1 lines. The lines varied significantly for their response to all characters. The range of days to first harvest was 101.00 to 112.00 days. Maximum marketable fruit number was obtained from F_1 4x213 (49.00), while the heaviest fruit was harvested from F_1 204A x206 (155.27 g). The maximum fruit yield was recorded from the line F_1 4×217A (81.81 t/ha), which was statistically similar with F_1 21x216 (78.56 t/ha) and followed by F_1 1×217A (64.95 t/ha), F_1 5x20 (70.02 t/ha), F_1 5×217A (67.64 t/ha), F_1 12x20 (60.23 t/ha), F_1 12x206 (68.94 t/ha), F_1 12x216 (67.51 t/ha), F_1 13x221B (62.31 t/ha), F_1 14x216 (64.82 t/ha), F_1 19x233 (65.95 t/ha), F_1 21x13 (61.14 t/ha), F_1 48x206 (71.15 t/ha), F_1 204A x206 (75.44 t/ha), F_1 253Ax11 (66.08 t/ha), F_1 262x11 (65.04 t/ha), F_1 EG203x216 (71.15 t/ha). The range of fruit infestation by BFSB was 7.05% (F_1 14x216) – 26.63 % (F_1 18x216). Considering earliness, higher yield, pest tolerance, fruit shape and colour, hybrids viz., F_1 4x217A, F_1 1x217A, F_1 5x20,F_1 5x217A, F_1 12x20, F_1 12x206, F_1 12x216, F_1 13x221B, F_1 14x216, F_1 19x233, F_1 21x13, F_1 21x216, F_1 48x206, F_1 204A x206, F_1 253Ax11, F_1 262x11 and F_1 EG203x216 were found promising, and may be put under trial for AYT in the next winter season.

Advanced yield trial of eggplant hybrids for summer

The study on the performance of five advanced eggplant hybrids was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the summer season of 2016 to develop new hybrids having tolerance to eggplant fruit and shoot borer and bacterial wilt. The hybrid F_1 5×11 took minimum 85.33 days to first harvest. The BARI Hybrid Begun-4 produced the highest marketable fruit number per plant (42.10). The line F_1 13X12 produced the heaviest fruit (110.23 g). The BARI Hybrid Begun-3 produced the longest fruit (19.13 cm), while F_1 13X12 produced maximum diameter fruit (6.46 cm). Zero percent bacterial wilt incidence was observed in F_1 5X11, BARI Hybrid Begun-3, BARI Hybrid Begun-4. Among the advance lines, the higher yield (46.28 t/ha) was produced by F_1 5X11 and F_1 13X229 (41.30 t/ha). Minimum infestation by eggplant fruit and shoot borer was observed in BARI Hybrid Begun-2 (7.82%) and F_1 (13x229 (9.18%). The results of the present study revealed that two hybrids viz., F_1 5X11 and F_1 13X229 were found promising for earliness, high yield, pest and bacterial wilt tolerance, fruit shape, fruit colour and may be put under trial for RYT in the next summer season.

Advanced yield trial of eggplant hybrids for winter

An evaluation with nineteen F_1's lines/ varieties was conducted at the farm of Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2016-17 to develop new high yielding hybrids having tolerance to eggplant fruit and shoot borer and bacterial wilt. The lines varied significantly ($P<0.05$) for their response the all characters studied. In respect of days to 1st harvest the earliest hybrid was F_1 21x223 and took minimum 100.00 days). The highest marketable fruit number per plant (56.66) was recorded from F_1 14x233 which was statistically similar with F_1 1x14 (52.33) and followed by F_1 222B x233 (51.66). The heaviest fruit was obtained from the hybrid F_1 21x13 (184.28 g). F_1 1x14 produced the longest fruit (27.33 cm), while the maximum diameter fruits ware produced by F_1 21x13 (9.00 cm). In case of bacterial wilt infection at field level performance, there were no incidence among the hybrids. The the highest yield (81.12 t/ha) was produced by F_1 21x13 which was statistically similar with F_1 14 x217A , F_1 18x233, F_1 EG203x5, F_1 EG203x217A, F_1 21x223 and followed by F_1 222B x233, F_1 EG203x1, F_1 13x229, F_1 5x11, F_1 14x233, F_1 EG203x14, F_1 3x229, F_1 5x233, F_1 EG203x233, while least was produced by another check variety F_1 19x4 (50.70 t/ha). Minimum infestation by BFSB was observed in F_1 EG203x1 (7.68%).

Considering earliness, higher yield, pest tolerance, fruit shape and colour, 16 hybrids viz., F_1 21x13, F_1 14 x217A, F_1 18x233, F_1 EG203x5, F_1 EG203x217A, F_1 21x223,F_1 222B x233, F_1 EG203x1, F_1 13x229 , F_1 5x11, F_1 14x233, F_1 EG203x14, F_1 3x229, F_1 5x233, F_1 EG203x233 were found promising, and may be recommended for AYT in the next year winter season.

Regional yield trial of eggplant hybrids for summer

The study on the performance of three advanced eggplant hybrids was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during the summer season of 2016 to develop new high yielding hybrids having tolerance to eggplant fruit and shoot borer and bacterial wilt. The hybrid F_1 1x19 took minimum 95.67 days to first harvest. The highest marketable fruit number per plant (42.20) was obtained in the check variety BARI Hybrid Begun-4 followed by F_1 1x19 (34.43), while heaviest fruit was obtained from the line F_1 21x13 (123.13 g) followed by F_1 1X5 (107.00 g). The F_1 1x19 produced the longest fruit (24.86cm), while fruits of maximum diameter was produced by the line F_1 21x13 (6.00 cm) followed by F_1 1X5 (4.30 cm). In case of bacterial wilt infection at field level performance, there was zero percent infection in F_1 1x19. The highest yield (47.78 t/ha) was produced by BARI Hybrid Begun-3 which was statistically similar with F_1 1x5 (44.01 t/ha), F_1 1x19 (44.77 t/ha). Minimum infestation by BFSB was 6.66% was observed in F_1 1x19 which was followed by F_1 1x5 (13.72 %). The results of the present study revealed that two hybrids viz., F_1 1x19, F_1 1x5 were found promising for earliness, high yield, pest and bacterial wilt tolerance, fruit shape, fruit colour and may be selected for release as new hybrid variety for summer season cultivation.

Regional yield trial of eggplant hybrids for winter

A study on the regional yield performance of five advanced eggplant hybrids was conducted at six experimental farm viz., Joydebpur, Akbarpur, Ishwardi, Jamalpur, Rahmatpur, Jessore of BARI during the winter season of 2016-17 to observe their yield and yield potentiality. On an average, the advanced hybrid line F_1 1x19 possessed the highest number of marketable fruits (28.83) per plant followed by F_1 14x5 (21.61) and the lowest was by F_1 13x12 (17.55). The corresponding yield was also highest in case of the F_1 13x12 (53.63 t/ha) followed by F_1 1x19 (51.74t/ha), F_1 14x5 (50.28 t/ha) and lowest was by F_1 20x5 (35.17 t/ha. Considering earliness, higher yield, bacterial wilt tolerance, fruit shape and colour, three hybrids viz., F_1 13x12, F_1 1x19 and F_1 14x5 were found promising and may be proposed for release as new hybrid variety.

Response of eggplant varieties to salinity in germination, seedling stages and field study

Eggplant (*Solanum melongena*) is moderately sensitive to salinity but more attention to salinity is required in the agricultural production of eggplant and its varieties. The objective of the present work was to investigate the response of some eggplant varieties to increasing salinity during the germination and seedling stages. This investigation was carried out in a lab study and solution culture at the Hydroponic Culture House of HRC, BARI, Gazipur, Bangladesh in winter season of 2016-17. Fourteen particular varieties (BARI Begun-1, BARI Begun-2, BARI Begun-4, BARI Begun-5, BARI Begun-6, BARI Begun-7, BARI Begun-8, BARI Begun-9, BARI Begun-10, BARI Bt Begun-1, BARI Bt Begun-2, BARI Bt Begun-3, BARI Bt Begun-4, BARI Hybrid Begun-4) of eggplant extensively cultivated in Bangladesh were used as plant material. Germination, length, and dry and fresh weight of root and shoot, severity of leaf symptoms, dry and fresh weight of root and shoot in seedling leaves, were the assayed parameters. Increasing salt stress (control, 2, 4, 6 and 8 dS/m salinity) negatively affected growth and development of eggplant varieties at the germination (percentage and period; length, fresh and dry weight of root and shoot). Based on the severity of leaf symptoms, BARI Bt Begun-1 and BARI Begun-1 were found to be most tolerant verities to salinity with score 1.0. Reduction of dry weight was found to be 13.10, 13.44% (shoot) and 12.77, 11.40% (root) in BARI Bt Begun-1 and BARI Begun-1, respectively, 25-74% (shoot) and 28-83% (root) in other varieties. Thus, in seedling experiment BARI Bt Begun-1 and BARI Begun-1 can be regarded as a breeding material for development of new eggplant varieties resistant to salinity. On the other hand, screening out of 14 eggplant varieties the 9 varieties; BARI Bt Begun-1, BARI Begun-1, BARI Begun-6, BARI Bt Begun-2, BARI Bt Begun-3, BARI Bt Begun-4, BARI Hybrid Begun-4, BARI Begun-9 and BARI Begun-7, reflected good performance in order to germination, symptom score, plant dry matter production under saline conditions. In field study 10 varieties were used for screening and BARI Bt Begun-1 and BARI Begun-1 variety were found salt tolerant in the saline zones of Bangladesh to have better production.

Screenibg of eggplant germplasm resistant to bacterial wilt

Twenty eggplant accessions were screened for resistance to *Ralstonia solanacearum* grown under artificial epiphytotic conditions in Horticulture research field at BARI during 2016-17 cropping seasons. The population of *Ralstonia solanacearum* was estimated before transplanting which was about 3.0 X10^9 cfu/ml. One month old seedlings of tomato were transplanted at 50 cm distance from row to row whereas plant to plant distance was 30 cm. Wilted plants were counted periodically and converted to percent wilt. Among the accessions, four lines such as SM 293, SM 279, SM 203 and 216 gave resistant reaction with 5% mortality. Nine lines of eggplant showed moderately resistant reaction. Two lines showed moderately susceptible reaction and five lines showed highly susceptible reaction to *R. solanacearum*. The moderately resistant lines will be tested for further evaluation for confirmation with other lines.

Screening of root stock against bacterial wilt for grafting eggplant variety

The experiment was conducted with grafting seedling where BARI Begun-8, *Solanum sisymbriifolium* and EG 203 were used as rootstock and BARI Tomato-4 as scion. Grafting seedlings were grown in artificially inoculated sick bed at HRC, BARI for resistance to bacterial wilt during June 16, 2016. The population density of the bacteria in the bed prior to set up the experiments was estimated about 3.0 X 10^9 cfu/ml of water. Among the three rootstocks *Solanum sisymbriifolium* was found highly resistant to bacterial wilt. While EG 203 and BARI Begun-8 were resistant with 3.85 and 6.82% mortality, respectively.

Screening of eggplant germplasm against root-knot nematode

Twenty eggplant accessions were screened for resistance to root-knot nematode grown under artificially inoculated sick plot in Horticulture research field at BARI during 2016-17 cropping seasons. One-month old seedlings of 20 eggplant germplasm were transplanted in three replications in nematode sick plot, having population of 2500-3500 RKN larvae per kg soil. The seedlings were transplanted 20 cm apart in rows having 30 cm space between rows. The root systems were indexed following 0-10 scale. Among twenty accessions, three lines (SM 206, SM 285 and SM 279) were found resistant, eight lines gave moderately resistant, five lines showed moderately susceptible and four lines were susceptible to root knot nematode.

Tomato

Varietal Impairment

Evaluation of new AVRDC tomato germplasm

An experiment on evaluation of tomato germplasm was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of 2016-17 with 15 AVRDC/WVC supplied tomato lines for selecting superior lines and seed increasing. All the lines showed different performance in every parameter studied. The line SL0307 contributed the highest per plant yield (4.14 kg) with good shelf life (19 days). The tomato lines SL0301, SL0303 (2), SL0308 (1) and SL0311 showed more than 3.00 kg yield per plant. The lines- SL0301, SL0303 (1), SL0304, SL0307, SL0308

(1), SL0303 (2), SL0311 and SL0313 found to be promising. Neither virus nor bacterial wilt observed to infect in the tomato lines. Four lines viz. SL0303 (1), SL0304, SL0303 (2) and SL0313 considered to be potential line for heat tolerance as noticed by the WVC (are being evaluated this summer season seed sown on May15, 2017). Rest of three lines may be put into PYT/AYT in winter season.

Screening of different tomato varieties in saline area

An experiment was conducted at the Agricultural Research Station (ARS), Bangladesh Agricultural Research Institute (BARI), Benarpota,Satkhira during the rabi season of 2015-16 to screen out saline tolerant tomato variety and to popularize BARI developed tomato varieties in saline prone areas of Bangladesh. There were nine tomato varieties viz.: BARI Tomato-2, BARI Tomato-14, BARI Tomato-15, BARI Tomato-16, BARI Tomato-17, BARI Hybrid Tomato-5, BARI Hybrid Tomato-8, BARI Hybrid Tomato-9 and local/company variety (cheek) included in this study. All parameters showed significant difference. BARI Tomato-17 gave the highest fruit yield (70.14 t/ha), while, other tomato varieties performed better in respect of yield (yield ranged from 61 to 66 t/ha) and Satkhira local had the lowest fruit yield (44.97 t/ha). The lowest level of soil salinity was recorded in sowing time (3.63 ds/m) and the highest level of salinity (10.35 ds/m) was recorded at the harvesting stage. BARI Tomato-varieties showed good adaptability in saline condition up to 10.35 ds/m. Therefore, the experiment may be repeated for confirming the results.

Regional yield trial of multiple disease tolerant AVRDC tomato lines

The study was conducted with five selected lines with a check at the experimental field of Olericulture Division, Horticulture Research Centre along with five different regional research stations of Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2016-17, to assess the yield potentiality and adoptability and at different agro ecological zones of Bangladesh. Significant variation was observed among the lines in respect of different characters studied. A wide range of variation in number of fruits (32-38) per plant was observed. Maximum fruit yield per hectare obtained from the line AVTO1317 (96.57 tones) followed by AVTO 1229 and AVTO1316 (90.33 and 90.33 tones) respectively. There was no virus infection found at Joydebpur (HQ) in all the lines except BARI Tomato-15. But at other stations, all the lines showed 3 to 8 percent virus infection. The tomato lines viz. AVTO1317, AVTO1229 and AVTO1316 found to be promising. The experiment may be repeated for confirming the results.

Regional yield trial of tomato lines for processing

A regional yield trial (RYT) of four processing tomato lines of AVRDC with check BARI Tomato-3 was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC) and at six regional agricultural research station (RARS) of Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of 2016-17 to assess the yield performance, processing quality and adaptability. Satisfactory number of fruit per plant was recorded from the all AVRDC lines which were ranged from 36-42. The highest fruit yield per hectare was obtained 80.75 tons from the line AVTO-01139. One of the main criteria of processing tomato is viscosity, which was ranged from 2.50 to 3.70 Cp in tomato lines while highest value (7.05 Cp) showed in BARI Tomato-3. The line AVTO01139 was found better in respect of yield and processing quality (viscosity). This line was proposed for releasing as variety and the line has already been released as BARI Tomato-19 (processing type) on March 2017.

Regional yield trial for dual purpose processing/fresh market tomato inbred lines

A regional yield trial was conducted on four tomato inbred lines to study the yield, diseases resistance and processing attributes at the experimental field of Olericulture Division of Horticulture Research Centre (HRC), BARI, Gazipur along with six different regional stations of BARI covering 30 AEZ of Bangladesh during the winter season of the year 2016-17. There were four selected inbred tomato lines (selected from the AVRDC supplied eight inbred tomato lines) viz.: SL0033=CLN3670B; SL0036= CLN3552C; SL0037=CLN3552B; and SL0038= CLN3125L-5x65 along with one local check BARI Tomato-19 was included in this study. In respect of fruit number per plant varied from 24 to 33, while the highest number of fruit (33) was counted in the line control as because it was genetically good fruit bearer type and the lowest number of fruits was counted in CLN3552B (24). The highest marketable fruit yield per hector was obtained from control (68.25 tones) while the line- CLN3670B exhibited statically identical quantity (67.22 tones) of fruit per hector. The lines showed good tolerance against virus infection which was ranged from 1-2%. Processing attributes showed that very little satisfactory magnitude lightness, hue angle, TSS, firmness, dry matter percentage, P^H and vitamin-C for fresh product. The same lies also showed better performance in terms of lightness, hue angle, pulp percent, final product percent and viscosity too in processed product. Considering the growth habit, diseases infection rating, shelf life, qualitative traits and yield, all lines were found to be promising. The experiment may be repeated in the following year to confirm the results.

Regional yield trial of t_Y gene inserted cherry tomato lines for yield and diseases resistance

A regional yield trial (RYT) of two selected cherry tomato lines of AVRDC and one advanced cherry tomato line with check BARI Tomato-11 was conducted at the experimental field of Olericulture Division, Horticulture Research Centre (HRC) and at five RARS of Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of the year of 2016-17 to assess the yield potentiality, pest and disease reaction and adaptability. The maximum fruit number per plant (204) was counted from the line SL0067, while the second highest number was recorded in the control. The lowest number of fruits per plant (83) was obtained from the line SL0012 because this line’s average fruit weight was higher than SL0067 and control. The maximum fruit yield per hectare (45.21 tones) was obtained from the line SL0011. But the yield difference between SL0011 and SL0012 is statistically identical. Virus infection was recorded ranged from 2-6% and no bacterial wilt was found. The beta-carotene content showed higher in the line SL0012 (227µg), while the second highest recorded in SL0011 (204µg) and the lowest beta-carotene exhibited from the line SL0067 (113µb). The line SL0067 is going to be proposed as beta-carotene rich cherry tomato variety.

Regional yield trial of t_Y gene inserted tomato lines for yield and diseases resistance

A regional yield trial (RYT) of five selected potential tomato lines of AVRDC with check BARI Tomato-15 was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC) and at five regional agricultural research station (RARS) of Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of the year of 2016-17 to assess the yield performance, pest and disease reaction and adaptability. The number of fruits per plant varied from 26 to 33. The highest fruit yield (69.22 tones) per hectare was obtained from the control, while the second highest yield (66.32 tones) was weighed from the line SL0003 followed by 66.07 tones recorded from the line SL009. Virus infection was recorded ranged from 3-10 %, while, no virus infection was recorded at head quarter (Joydebpur) except control. No bacterial wilt the found to infect in the tomato lines studied. The experiment may be repeated for confirming the results.

Responses of tomato varieties to different salinity levels

A pot experiment was conducted at the research field of Olericulture Division, Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the rabi season of 2016-17 to investigate the effect of salinity stress in tomato varieties. Four tomato varieties viz., BARI Tomato-2 (BT2), BARI Tomato-3 (BT3), BARI Hybrid Tomato-5 (BHT5) and BARI Tomato-14 (BT14) were included in this study. Seeds were sown on earthen bowls full of sandy soil with cowdung (50:50), then moistened with saline water (0, 8, 12 and 16 dS/m) and continued upto transplanting stage. After 30 days, the seedlings were transplanted into 15 L pots containing soil and recommended doses of manures and fertilizers. The plants were irrigated with 0, 8, 12 and 16 dS/m saline water and continued upto final harvest. The results revealed that soil salinity markedly reduced seed germination, weight of seedling and length of shoot and root, plant height, number of leaves/plant, number of fruits/plant, individual fruit weight and fruit yield/plant in all tomato varieties. BHT5 and BT2 provided maximum no of fruits/plant under control and 8 dS/m salinity. At both of 12 and 16 dS/m salinity, BT3 provided minimum fruits/plant. Under control and stressed condition BT2 and BT14 provided larger fruits as compared to BT3 and BHT5. BT2 provided higher fruit yield under control and 8 dS/m salinity, whereas; yield of all tomato varieties under 12 and 16 dS/m were negligible. At salinity stresses, plants of BT3 were injured more as higher compared to other varieties and subsequently died at later stage. However, none of the varieties were found to be tolerant to higher salinity. Since no biochemical analysis was carried out, the repetition of this experiment with proper biochemical analyses is recommended.

Regional yield trial of summer hybrids of tomato

The study consisting of four hybrids and BARI Hybrid Tomato-4 and 8 as check varieties was conducted at two locations of BARI which include Joydebpur and Ishurdi in the summer season of 2016-17. Data of these locations were combined for interpretation. All the test hybrids produced similar or lower marketable fruits per plant (MF/plant) (9-13) compare to the check varieties (11-15). Average fruit weight (AvFwt) was higher in all the test hybrids (60-71.6g) than the check varieties (41.6-58.7g). Three hybrids (WS12 Hybrid 50, 53 and 61) also produced higher marketable yield per hectare (24.7-29.5 tons) over both the check varieties (22.4-23.8 tons). Maximum yield was recorded in WS12 Hybrid 61 (48.4 t/ha) while lower in the checks (33-36.3 tons/ha) at Joydebpur location. Virus incidence in the test hybrids was lower which ranged from 2.1-3.6% for TSWV and 2.1-4.3% for TYLCV. Higher virus incidence was recorded in the checks which ranged from 5.8-10.1% for TSWV and 6.5-11.6% for TYLCV. Considering all the parameters studied, necessary steps can be taken for releasing hybrid WS 12 Hybrid 61.

Regional yield trial for dual purpose processing/fresh market tomato inbred lines

A regional yield trial was conducted on four tomato inbred lines to study the yield, diseases resistance and processing attributes at the experimental field of Olericulture Division of Horticulture Research Centre (HRC), BARI, Gazipur, Bangladesh during the winter season of the year 2016-17, to assess the yield potentiality, processing quality and adoptability. There were four selected inbred tomato lines (selected from the AVRDC supplied eight inbred tomato lines) viz., SL0033=CLN3670B; SL0036= CLN3552C; SL0037=CLN3552B; and SL0038= CLN3125L-5x65 along with one local check BARI Tomato-19 was included in this study. The findings of major parameters revealed that: days to 50% flowering was observed uniform and earlier than control that was confined in 46-48 days. It may be due to the genetic potentiality as the lines are inbreeds. In respect of fruit number per plant varied from 36 to 49, while the highest number of fruit (49) was counted in the line control as because it was genetically good fruit bearer type and the lowest number of fruits was counted in CLN3552B (36). In the case of average fruit weight, the largest fruit was harvested from CLN3552B (91.67g) followed by CLN3552C (87.66g) and the smallest average fruit weight were obtained from CLN3670B (83.33 g). The length and diameter of fruits of different lines also varied significantly. The marketable fruit yield per plant varied from 2.42 to 2.66kg. The highest marketable fruit yield per hector was obtained from control (66.94 ton/ha) while other lines also exhibited statically identical quantity of fruit per hector. All the lines showed good resistance on EB, LB, TYLCVD, BW, FW, SB and TFB. In respect of postharvest attributes, all the lines specially control line showed satisfactory magnitude lightness, hue angle, TSS, firmness, dry matter percentage, P^H and vitamin-C for fresh product. The same lies also showed better performance in terms of lightness, hue angle, pulp percent, final product percent and viscosity too in processed product. Considering the growth habit, diseases infection rating, shelf life, qualitative traits and yield, all lines found to be promising and may be put into repeated regional yield trial (RYT) in the following year to confirm the results.

Regional yield trial of summer hybrid tomato lines

Performance of three hybrids of summer tomato viz., CLN-3150-A-5×CLN-3125-0-19, CLN-3324A× CLN-3125-0-19 and CLN-3124A×CLN- 3241AA with BARI Hybrid Tomato-8 were evaluated at Regional Agricultural Research Station, Ishurdi, Pabna during kharif season of 2016 to observe the yield potential and overall performance of the develop hybrids in summer-rainy season without hormone application under Ishurdi condition. The highest number of fruits per plant (15.59) was obtained from BARI Hybrid Tomato-8 which was statistically similar to CLN-3150-A-5×CLN-3125-0-19 (14.66) and the lowest (8.75) was recorded in CLN-3124A×CLN- 3241AA. The highest average fruit weight (67 g) was recorded in CLN-3150-A-5×CLN-3125-0-19. The highest yield (17.45 t/ha) was recorded from CLN-3150-A-5×CLN-3125-0-19, while the lowest (9.70 t/ha) was obtained from CLN-3124A×CLN- 3241AA. Though CLN-3150-A-5×CLN-3125-0-19 produced the highest yield but not yet satisfactory. For more confirmation, the trial should be continued for the next year.

Regional yield trial of summer f_1s of tomato

Six advanced F_1s tomato lines and BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 were evaluated at Regional Agricultural Research Station, Ishurdi, Pabna during kharif season of 2016 to observe the yield potential and overall performance of the develop hybrids in summer-rainy season without hormone application under Ishurdi condition. Early flowering (52 days) was found in BARI Hybrid Tomato-4 whereas, delayed flowering (61 days) was observed in S-12 Hybrid-61. Number of fruits per cluster (2.26) was maximum in WS Hybrid-3(b). The highest number of fruits per plant (8.27) was obtained from BARI Hybrid Tomato-4. Only one line i.e. WS Hybrid-3 (b) was found superior than check variety. However, the highest yield (18.05 t/ha) was recorded from WS Hybrid-3 (b), while the lowest (6.84 t/ha) was obtained from S-12 Hybri-53. For more confirmation, the trial should be continued for the next year.

Possibilities of using side shoots as propagation materials in tomato production

A study was conducted at vegetable research field of Olericulture Division, Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the winter season of 2016-17. The axillary/lateral shoots (10-12 cm long) were taken from BARI Hybrid Tomato-5. The cuttings were dipped for 5 minutes in 100, 150, 200, 250 and 300 ppm solutions of Indole Butyric Acid (IBA), and control (Water dipped) and statistically analyzed Effect of the treatment were compared with planted in polybag filled with a mixture of well decomposed farm yard manure (FYM) and soil (1:1) and observed one month. All the treatments were triplicated using randomized complete block design. The results showed that treatment with 200 ppm of 1BA dipped was found higher survival % of shoot cuttings (100%), number of roots per cutting (73), longer root length (17.43cm) followed by IBA 150 ppm was more effective in enhancing the rooting effect and root length of tomato cutting compared 100 ppm and even 250 ppm and 300 ppm concentration of 1BA and control. Therefore, 200 ppm IBA dipped cuttings may think to be the best treatment that will produce more roots as well as better side shoot seedlings of tomato.

Performance of BARI released tomato varieties at northern region during late winter

A study on performance of BARI released tomato varieties at northern region during late winter was carried out at Agriculture Research Station (ARS), Thakurgaon during the late winter season 2017 in order to compare the performance of BARI released tomato varieties and farmers' collected hybrid tomato verities at northern region of Bangladesh. Eight tomato varieties/lines were included for study. The varieties/lines were: BARI Tomato-14, BARI Tomato-15, BARI Tomato-16, BARI Tomato-17, NS 501, NS 538, Tomato 1389 and Bipul plus in a RCB design with three replications. The findings of the study revealed that number of fruit in 2nd cluster (4.07), was higher in hybrid tomato line NS 501followed by hybrid Tomato 1389, BARI Tomato-14 and BARI Tomato-15. Number of fruit per plot also higher in NS 501(133), Bipul plus (120.67) and BARI Tomato-15 (114). Fruit yield were recorded the highest in Bipul plus (27.68 t/ha), BARI Tomato-16 (27.00 t/ha), BARI Tomato-15 (26.25 t/ha), and NS 501 (25.74 t/ha). From the study it was also clear that BARI Tomato-15, BARI Tomato-16 were higher yielder (26.25 and 27.00 t/ha) during late winter which was superior over rest of the tested tomato varieties/lines and comparable with Tomato 1389 (23.88 t/ha) followed by NS 538 (19.98 t/ha) which were the most preferred compared to hybrid tomato lines cultivated by the farmers of northern region of Bangladesh.

Effect of containers and vermi-compost on tomato under roof-top gardening

An experiment was carried out at roof top of Olericulture Division under Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), to find out the suitable container and vermi-media for growing tomato (BARI Tomato-15) for the roof top gardening during October 2016 to March 2017. The two factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Treatment combinations were container, namely, plastic, earthen and sac bag and level of vermi-compost viz., 0, 50 and 75 percent (% weight basis) mixed with soil. The 30 days old seedlings were transplanted on 29 November, 2016 into a plastic pot, earthen pot, and sac bag which contained around 12 kg of media. The containers were filled with a mixture of soil and half amount each of the vermi-compost. The remaining amounts of vermi-composts were equally divided into two portions; one was applied at 21 days and 2nd was applied at 35 days after transplanting as top dressing. From combined effect, it was found that the maximum days to 50 % flowering (61.00 days) recorded from sac bag with 0 % vermi compost + 100 % soil and the minimum (48.33 days) was recorded from earthen pot with 75 % vermi compost + 25 % soil. The maximum no. of fruit (30.33) was recorded from plastic pot with 50 % soil + 50 % vermi compost and the minimum (11.66) was recorded from plastic pot with 0% vermi-compost + 100 % soil. The heaviest fruit (49.10 g) was obtained from sac bag with 50 % soil + 50 % vermi compost and the smallest fruit (20.94 g) was from earthen pot with 100 % soil. The highest identical tomato yield (1.14 and 1.23 kg) were recorded from the plastic and sac pot with same level of vermi compost (50 % soil + 50 % vermi-compost) while the lowest (0.22 kg) was obtained from sac bag with 100 % + 0 % vermi-compost. The highest identical TSS (% Brix) (6.30 to 6.33) were recorded from earthen pot with 0% vermi-compost + 100 % soil and sac bag with 75 % vermi-compost + 25 % soil. So, it may be concluded that plastic pot with 50 % vermi compost + 50 % soil and sac bag with 75 % vermi compost + 25 % soil were suitable combination for tomato production under roof top gardening.

Performance of hybrid tomato varieties against salinity during germination and early seedling growth stage

The experiment was carried out at the Plant Physiology Laboratory of HRC, BARI, Gazipur during 05 December, 2016 to 30 December, 2016 to find out the salinity tolerant tomato genotypes during germination and early seedling growth stages. The response of six hybrid tomato genotypes viz. BARI Hybrid Tomato-8 (V_1), BARI Hybrid Tomato-9 (V_2), BARI Hybrid Tomato-4 (V_3), BARI Hybrid Tomato-5 (V_4), BARI Hybrid Tomato-7(V_5), Hybrid Tomato (Unnyan) (V_7), Hybrid Tomato (Mintu) (V_6), Hybrid Tomato (Comet) (V_8) against four levels of salinity viz. 0 dS/m (S_0), 4 dS/m (S_1), 8 dS/m (S_2) and 12 dS/m (S_3) were studied in this experiment. The germination rate and seed vigour index along with other attributes were reduced with increasing the salinity levels. Compared with 8 tomato genotypes, BARI Hybrid Tomato-8 (V_1) performed relatively better at 12 dS/m with respect to germination and early seedling stage that was followed by BARI Hybrid Tomato-9 (V_2), BARI Hybrid Tomato-4 (V_3) and BARI Hybrid Tomato-5 (V_4). The performance of Hybrid Tomato (Comet) (V_8) was poor compared to other varieties.

Growth and yield of winter tomato varieties as influenced by planting time

The experiment was carried out at the Plant Physiology Field of Horticulture Research Center, Bangladesh Agricultural research Institute, Gazipur during October 2016 to May 2017 to investigate the influence of planting time based temperature on physio-morphological characters and yield potentiality of tomato varieties in different sowing time. Tent treatment combinations comprising five planting time viz. October 15, November 15, December 15, January 15 and February 15 and two open pollinated tomato varieties viz., BARI Tomato--16, BARI Tomato- 17) were studied. The experiment was laid out in RCBD (Factorial) with three replications. Plant height, primary branches/plant, fruit size (length and width) individual fruit weight, fruit set percent, shoot and root dry weight were found maximum from BARI Tomato-17 with October 15 planting, followed by the same variety with November 15 planting. BARI Tomato-16 coupled with October 15 planting produced the maximum chlorophyll content (CCI value), maximum photosynthetic yield (Fv/Fv value) and the highest number of fruits/plant which were followed by the same variety with November 15 planting. Maximum number of inflorescences/plant was obtained from BARI Tomato-17 planted on October-15 which was identical with BARI Tomato-16 with the same planting. The Maximum fruit yield both per plant and hectare was recorded from BARI Tomato-16 with October-15 planting followed by BARI Tomato-17 with the same planting and November-15 planting coupled with both the varieties. Irrespective of the planting time, BARI Tomato-16 appeared to be the highest fruit yielder than BARI Tomato-17. Irrespective of varieties, January-15 and February-15 planting gave the inferior result for yield attributes and yield. Based on the results, it can be concluded that BARI Tomato--16 and BARI Tomato--17 showed better performance on physio-morphological characters and yield potentiality planted in mid October, which was followed by mid November planting. Irrespective of the planting time, the variety BARI Tomato-16 outyielded the variety BARI Tomato-17. However, further trial should be conducted including October 01 planting for confirmation of the results.

Effect of USG and boron application on the yield and quality of summer tomato

The experiment was conducted on summer tomato (BARI Hybrid Tomato-8) at the research field of HRC, BARI, Gazipur, Bangladesh during summer season of 2015-16 in RCBD with three replications. Six treatments were considered as- i) Recommended dose of N as USG +2 kg B ($N_{140}B_2$) ii) Recommended dose of N as USG – B ($N_{140}B_0$); iii) 85 % recommended dose of N as USG + 2 kg B ($N_{125}B_2$); iv) 85 % recommended dose of N as USG – B ($N_{125}B_0$); v) 70 % recommended dose of N as USG + 2 kg B ($N_{105}B_2$) vi) 70 % recommended dose of N as USG – B ($N_{105}B_0$) and vii) Control. From two years study it was observed that USG and B application have the significant effects on summer tomato production. Results revealed that recommended dose of N as USG + 2 kg B/ha ($N_{140}B_2$) showed better performance with the highest yield of 38.51 t/ha in 2015 but in 2016, 85% recommended dose of N as USG + 2 kg B/ha ($N_{125}B_2$) showed the best performance with maximum yield of 43.25 t/ha. From economic analysis 85% recommended dose of N as USG + 2 kg B/ha ($N_{125}B_2$) was found the most economically viable dose (BCR 2.44 and 2.89) for both the year for summer tomato production. Also the higher fruit setting, fruit size and fruit quality eg.TSS (4.73 % and 4.70) were found from USG treated plants where 2 kg B was used.

Effect of different levels of magnesium on the yield and quality of tomato

A study was conducted at the research field of HRC, BARI, Gazipur, Bangladesh during 2016-17 to estimate the effective doses of magnesium (Mg) for Tomato var. BARI Tomato-15) yield maximization in Bangladesh. There were 4 treatments viz. T_1 = Control, T_2 = Mg 4.0 kg ha^{-1}, T_3= Mg 8.0 kg ha^{-1}, T_4= Mg 12 kg ha^{-1} along with the blanket dose of $N_{140}P_{45}K_{90}S_{18}Zn_4B_2$ kg ha^{-1} and cow dung 5 t ha^{-1}. The experiment was designed randomized complete block with three replications. The results showed that the marketable yields of tomato ranged from 25.8-56.0 t ha^{-1}. The highest tomato yield (56.0 t ha^{-1}) was obtained from the treatment T_4. The lowest yield was found in control plot (T_1). The TSS (%) of tomato varied due to different treatment from 4.41-5.19%. The highest TSS (5.19%) was estimated from T_4 treatment. The highest net return (Tk. 730326 ha^{-1}) was counted from T_4 treatment. The highest benefit cost ratio 7.71 was counted from the treatment T_3. The lowest net return was calculated from control treatment and the lowest benefit cost ratio was also counted from the T_1

treatment. Considering the benefit cost ratio of the treatment T_3= 8 kg Mg ha^{-1} may be considered as low income farmers of Bangladesh for tomato production. But on the basis of highest net return and yield T_4 is superior. Therefore, it is clear that farmers should be used 12 kg Mg ha^{-1} for tomato production.

Screening of tomato germplasm resistant to bacterial wilt

Ten tomato accessions were screened to find out bacterial wilt resistant source grown under artificial epiphytotic conditions in Horticulture research field at BARI during 2016-17 cropping seasons. The population density of the bacteria in the bed prior to set up the experiments was estimated about 3 X 10^9 cfu/ml of water. Continuous sowing with 3 replications were followed. 25 days old seedlings of tomato were transplanted at 45 cm distance from row to row whereas plant to plant distance was 30 cm. Wilted plants were counted periodically and converted to percent wilt. Among the accessions, four accessions like GWT 052, SL 0011, BARI Tomato-3 and BARI Tomato-15 gave resistant reaction. Three accessions of tomato were showed moderately resistant reaction to *R. solanacearum*, two lines showed moderately susceptible reaction and one line was highly susceptible to *R. solanacearum.*

Screening of tomato germplasm against root-knot nematode

Ten tomato varieties/lines were tested in atificially inoculated sick plot in Horticulture research field at BARI for their resistance to root- knot nematode. Twenty five days old seedlings of tomato germplasms were transplanted in sick plot having population of 2500-3500 RKN larvae per kg soil with 20 cm apart in rows having 30-cm space between rows. After 60 days of planting, the root systems were indexed following 0-10 scale. Among the accessions, four lines (SL 0012, BARI Tomato-11, GWT 062 and BARI Tomato-2) showed moderately resistant, two lines showed moderately susceptible and four lines gave susceptible reaction to root knot nematode.

Screening of tomato germplasm for resistant to tomato yellow leaf curl virus disease

The experiment was conducted in Horticulture research field, BARI, Gazipur during winter 2016-17 cropping season with some promising variety and lines of tomato to find out resistant sources against Tomato Yellow Leaf Curl Virus (TYLCV) disease. A total of ten tomato variety/ lines were evaluated. None of them was found to be highly resistant (HR) to TYLCV disease. Six variety/ lines (BARI Tomato-11, GWT 0062, BARI Tomato-2, SL 0011, SL 0012 & BARI Tomato-15) were resistant (R) and three (GWT0052, GBT 0037 & BARI Tomato-3) were moderately resistant (MR). Only BARI Tomato-8 (susceptible check) was moderately susceptible (MS) to TYLCV disease. Higher yield per plant was obtained from GWT 0062, SL 0011, SL 0012, BARI Tomato-15, BARI Tomato-3 and BARI Tomato-2. Disease incidence was positively correlated with whitefly population. Considering both disease and yield SL 0011 and BARI Tomato-15 may be recommended the best line and variety, respectively.

Management of TYLCV disease through chemical and cultural means

The experiment was conducted at Horticulture research field, BARI, Gazipur during winter 2016-17 cropping season to select suitable management practice (s) for Tomato Yellow Leaf Curl Virus (TYLCV) disease of tomato. BARI tomato-8 variety was used. Five treatments viz: yellow polyethylene mulch, straw mulch, barrier crops, neem seed oil and control (Admire) were evaluated. Among them, yellow polyethylene mulch reduced the maximum disease incidence and severity, and increased yield of tomato. Moderate disease incidence and medium yield was obtained from straw mulch treatment. Neem oil and barrier crop reduced yellowing and leaf curl symptom development in upper leaves but yield was similar to control (Admire) treatment. In 2015 higher yield was recorded in straw mulch and moderate in yellow polyethylene mulch. While in 2016, the maximum yield was recorded in yellow polyethylene mulch followed by straw mulch which is similar to this year results. Therefore, yellow plastic mulch may recommend controlling whitefly population and management of TYLCV disease in tomato.

Monitoring of tomato leafminer, tuta absoluta in different region

Monitoring was done in Research and growers' tomato fields in different places of Bangladesh like, Gazipur, Comilla, Moulvibazar, Sylhet, Panchagarh, Gaibandha, Mymensingh, Bogra and Jessore separately installing delta traps containing Tuta lures during November 2016 to May 2017. In each fields two delta traps were installed. Weekly capture of *T. absoluta* male moth was observed and counted. From the results it could be said Tuta has already been dispersed everywhere especially in tomato growing areas in Bangladesh by this time. This was the second year results. So research should be started on management against this pest.

Postharvest management

Technical and economic feasibility of improved postharvest management system in tomato value chain

Postharvest technologies and best practices were piloted in the existing tomato value chains in Bangladesh to manage quality and reduce postharvest losses in the supply chain. The pilot was conducted at Sherpur, Bogra, a commercial vegetable growing area, with an active growers' association called Vatra Utar Para CIG (Fosol) Ltd., alongside traditional practices in order to measure the impacts of improved technologies and practices. Interventions piloted in the "improved value chain" included the use of collecting pails and field plastic crates during harvesting, trimming the long stems of tomatoes close to the fruit shoulder, washing in chlorinated water, and packing in 25-kg plastic crates lined with newspaper on all sides and at the bottom. The traditional practice consisted of using bamboo baskets as collecting containers, no trimming and washing, and packing tomatoes in 50-kg red mesh sacks. Tomatoes were then transported from the collection center in Bogra to the wholesale market in Gazipur (about 173 km) then to retail shops also in Gazipur. The use of stackable 25-kg plastic crates resulted in 89% reduction in the incidence of mechanical damage and 100% reduction in losses upon arrival in the wholesale market. The main cause of postharvest loss amounting to 16.7% was fruit cracks obtained at the bottom portion of the red mesh sacks. During the 3-day retail period, there was higher recovery of good quality sound tomatoes in plastic crates than the red mesh sacks. The proportion of unmarketable tomatoes (representing losses) on the day 3 of retail was 25% in red mesh sacks and only 4.6% in plastic crates. The average reduction in mechanical damage with the use of plastic crate amounted to 58% during the 3-day retail. The total reduction in postharvest loss of tomato with the use of plastic crate lined with newspaper amounted to 89% upon arrival in the wholesale market and 3-day retail period. Through a partial budget analysis it was estimated that the additional gross weekly income of a trader by selling 1000 kg of tomatoes using plastic crates as a packaging container in the improved practice would be BDT 6,017. Thus, the interventions piloted proved highly beneficial for the tomato industry in Bangladesh and would help to promote export.

Enhancing the ripening process of tomato using ethephon and low-cost ethylene gas generator

An experiment was carried out to find out the effectiveness of ethephon and 'Ethylene Generator' on ripening and quality of winter tomato cv. BARI Tomato-14 (*Solanum lycopersicum* L.). Tomatoes were harvested at breaker-turning stage and exposed to ethylene gas that generated from ethephon (48 SL) by low-cost simple 'Ethynene Generator'. Two concentrations of ethephon i.e. 150 and 300 ppm were used as source of ethylene gas. Tomatoes were exposed to ethylene gas for 24h and 48h at ambient storage (27±1°C and 70±5% RH) condition for uniform ripening. Ethylene gas generated from 150 or 300 ppm ethephon exhibited the highest efficacy in fruit ripening. Exposure of tomato fruits to ethylene gas for 48h showed better performance compared to 24h.Treatment with ethylene gas resulted in 99% fruit ripe with uniform red colour, desirable firmness and acceptable quality after end of six days storage. Untreated control fruits, on the other hand, also ripened with acceptable colour and quality, but took longer time (8 days) for complete ripening. Hence, 'Ethylene Generator' may be used as a low-cost tool for generating ethylene gas that would be applied for safe and uniform ripening of tomato.

Sweet pepper

Varietal Impairment

Evaluation of sweet pepper genotypes during early and late winter

The experiment was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agriculture Research Institute (BARI) during the season of 2016-17 with eight sweet pepper genotypes to evaluate their performance in early and late winter season. In early and late winter the genotype CA 007 showed earliness (26 days and 28 days, respectively) and others were at per while range was (32-39 days) while Mistimorich 1 & Mistimorich 2 took the longest time (41-42 days). There was no significance difference in harvest duration. In early and late winter harvest duration range was 42-67 and 59-69, respectively. In early and late winter plant height range was almost similar. Fruit length and breadth range were 9.70-11.23cm and 9.3-11.26cm; 5.73-7.53 cm, respectively at early and late winter planting. In early winter number of fruit per plant was comparatively higher than late winter and the range were 4.47-22.37 and 5.80-17.27, respectively. The line CA 011 produced maximum number of fruit (22.37) in early but at late winter the highest number of fruit (17.27) was recorded from the genotype CA 010. In early winter BARI Mistimorich 1 produced the heaviest fruit (68.77g) while in late winter CA 014 produced the heaviest fruit (96.20g). The genotype CA 011 (1.78kg) and CA 014 (1.67kg) produced the highest fruit yield per plant in early winter while the line CA 007 (914.40g) produced the highest fruit yield per plant followed by CA 011 (835.50g) in late winter. Same trend was observed in calculated per hectare yield. Total soluble solid was almost same in both the season. Considering sowing time, yield and other horticultural traits the line CA 011 and BARI Mistimorich-2 may be suitable for both planting time, beside this, BARI Mistimorich 1 may be selected for earliness and bigger size fruit.

Advanced yield trial of coloured sweet pepper lines

The experiment was conducted at the experimental field of Olericulture Division, Horticulture Research Center. (HRC), Bangladesh Agriculture Research Institute (BARI), Gazipur during the winter season of 2016-17 to evaluate the seven sweet pepper lines collected from AVRDC and other sources with a view to develop inbred and line. From this trial it was found that most of the genotypes showed good performance in respect of yield and yield contributing characters. Earlier flowering was recorded from the line CA 0034 (62 days) and the earlier harvest was exhibited from the line CA 0030 (87.21 days). The highest number of fruits per plant was recorded from the line CA 0034 (9.05), this sequence also found in weight of fruits per plant (0.95 kg). The highest edible fruit weight was also found in the same line and it was 110.40g. The line CA 0034 produced highest fruit yield (38.0 t) among the evaluated lines, which was followed from the line CA 0033 (32.4 t/ha). The lowest yield was obtained by the line CA 0025 (21.6 t/ha). All the genotypes were found promissing for their yield, color, shape and size of fruits. The line CA 0034, CA 0033, CA 0026 and CA 0031 may be selected for the next year evaluation as Regional Yield Trial (RYT).

Inbred development in sweet pepper

The trial was conducted at the experimental field of Vegetable Division, HRC, BARI, Joydebpur in winter 2016. Eight S_0 and S_1 generations of sweet pepper lines were advanced to S_2 to S_3 generations respectively to develop variable sweet pepper inbred lines for the development of good hybrid varieties. Variations were found among the lines for the characters studied. Duration of fruit harvest (DFtH) varied from 58-66 days, fruit length 9.0-11.8 cm, marketable fruits per plant (MFPP) 9-18, average fruit weight (Av.FWt.) 45.5-68.2g, yield per plant 0.51-1.16 kg and mite infestation (%FtFlyInfest) 0.0-8.1% and fruit diameter (Fruit dia) 5.5-6.9 cm. Best individuals from every line of sweet pepper were selected and selfed. Seeds of S_0 to S_1 progenies of sweet pepper lines were stored for advancing S_2 to S_3 progenies in the next year.

Advanced yield trial of sweet pepper hybrids

This study of two selected F_1's of Sweet pepper ($F_1$1x2, $F_1$2x3) with a check was conducted at the farm of Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Gazipur during the winter season of 2016-17. The hybrid 2x3 took the minimum days to 1st harvest (66.25 days). The highest number of fruits per plant (28.40) was recorded from $F_1$1 x 2. The heaviest fruits (114.8g) were obtained from F_1 2x3. Fruit weight per plant was found maximum (2.54kg) in $F_1$1 x 2 followed by the $F_1$2 x 3 (1.42kg). The highest yield was produced by $F_1$1 x 2 (57.05 t/ha) followed by the $F_1$2 x 3 (28.37 t/ha). Minimum infestation by fruit borer (1.02%) was observed in $F_1$1 x 2, This hybrid line also performed well against white fly and mite infestation. All the studied lines were differed in various colors, which are varied from red to yellow in matured stage. These two hybrids $F_1$2 x 3, $F_1$1 x 2 were found promising for earliness, high yield, color variation and insect pest reaction. So these two lines may be recommended for further evaluation for their yield and quality.

Cauliflower and broccoli

Varietal Impairment

Purification of BARI Fulcopi-1 (rupa) variety through mass selection

The study was undertaken with BARI Fulcopi-1 and selected population of segregated line at experimental field of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural research Institute(BARI), Gazipur during the winter season of 2016-17 to purify degenerated population for original varietal characters. The segregating population of BARI Fulcopi-1(check) and the selected population to its original type were used as planting material in this study. In respect of days to 50% curd initiation and days to curd harvest of degenerated line required average 77 days and 81 days to first curd harvest, while BARI Fulcopi-1 required 81 days to curd initiation and 89 days for curd harvest. Almost similar numbers of leaves were observed in both the population, Leaf length (51.78cm) was found somewhat longer in plants from degenerated population but leaf breadth (58.32cm) was shorter than BARI Fulcopi-1 (66.24cm). Curd length and breadth was smaller in BARI Fulcopi-1 than selected degenerated lines. The curd length and breadth were (15.32cm and 11.24 cm) in degenerated lines while BARI Fulcopi-1 produced (11.0 and 9.5 cm) respectively. Comparatively higher marketable curd weight (910g) was produced by selected population while (805 g) was by BARI Fulcopi-1.Considering single curd weight due to higher curd length and breadth selected population produced higher curd wt. (665g) but BARI Fulcopi-1 produced (575g). The average yield (21.45t/ha) from degenerated population while BARI Fulcopi-1 was (18.70t/ha). Moreover, creamy whitish color and compact curd was observed in the selected population which indicates the original varietal character of BARI Fulcopi-1. Considering the qualitives and quantitives characters, segregated line became 90% similar to BARI Fulcopi-1. So may be concluded that selected degenerated line will ready to further production.

Regional yield trial of advanced summer cauliflower lines

The experiment was conducted with two advanced cauliflower lines with one check variety at the three location of BARI which included Joydebpur, Jamalpur and Comilla during the season of 2016-2017 to observed the performance summer cauliflower lines. In average of three location, the line CL-0172 required the lowest days (83.01days) and BARI Fulcopi-1 and Maradona took the highest days (89.94 days) to curd harvest. The highest marketable curd weight /plant (427.43g) was recorded from the advanced line CL- 0172 which was followed by the line CL-0171 (318.0g) and the lowest marketable curd weight / plant (481.56 g) was recorded from BARI Fulcopi-1. The highest calculative per hectare yield (24.33 t) was recorded from the line CL-0172 and the lowest yield (19.32 t)s was also recorded from the variety BARI Fulcopi-1. Considering the overall performance the advanced line CL-0172 is being proposed to release as an early variety.

Advanced yield trial of selected broccoli lines

The experiment was conducted at research field of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of 2016-17 with two selected OP broccoli lines and BARI Broccoli-1 was used as check to evaluate their yield performance. The highest curd length (15.32cm) was recorded from the line BARI Broccoli-1 and the highest curd breadth (18.44 cm) was recorded from the line BOI014. The highest curd weight/ plant (511.3g) was obtained from the line BOI002 which was at per to the line BOI014 (425.20 g). The highest marketable curd weight/plant (596.70 g) was recorded from the line BOI014, followed by the line BOI002 (502.30 g). The highest per hectare curd yield (10.14 t) was recorded from the line BOI014 followed by the line BOI002 (9.18t), while the lowest per hectare curd yield (5.55 t) was recorded from the line BARI Broccoli-1. On the basis of uniform curd shape, compactness and yield the line BOI002 and BOI014 were selected to verify their yield performance and seed production potentiality in local climate.

Cultural Practice

Effect of NACL pre-treatment on adaptation of cauliflower to salinity stress

A pot experiment was conducted at the Olericulture Division, Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the rabi season of 2016-17 to investigate the effect of NaCl pre-treatment in cauliflower when exposed to different salt treatments. Two cauliflower varieties; BARI Fulkopi-1 (BF1) and White Mountain Hybrid (WMH) were included in this study. Seeds were primed with 0, 0.5 and 1M NaCl solutions for 36 h. Seeds were sown for germination, treated with saline water (0, 4, 8, 12 ds/m) and continue up to transplanting. After transplanting into 15-L pots containing soil and recommended doses of manures and fertilizers, plants were subjected to 0, 4, 8 and 12 dS/m salinity and maintained upto final harvest. The results revealed that percentage of seed germination were severely inhibited by soil salinity. Priming with 0.5 M NaCl gave somewhat higher seed germination (%) under salt stress for both of BF1 and WMH but that was severely inhibited under 12 dS/m salinity. Length of root of seedlings increased with increased salinity and at higher salinity (8 and 12 dS/m) 0.5M and 1.0 M NaCl gave maximum length in BF1 and WMH, respectively. Total plant weight, leaves/plant and individual leaf weight (ILW) at harvest reduced significantly with increasing salinity. However, no significant variation was observed among different treatments in terms of days to curd initiation but curd weights in both varieties were reduced significantly due to soil salinity. At higher salinity, priming with 0.5M NaCl provided better curd yield in BF1 but no significant effect of priming was revealed for curd weight in WMH.

Effect of GA_3 and NAA on growth and yield of cabbage

Field experiments were conducted at the Plant Physiology Field of Horticulture Research Center, Bangladesh Agricultural research Institute, Gazipur during the *rabi* seasons of 2015-16 and 2016-17 to study the response of cabbage (var. Krishibid Hybrid-1 and Atlas-70) to foliar application of GA_3 and NAA with different concentrations. The experiment was laid out in randomized complete block design with three replications. The experiment consisted of eight growth regulator treatments viz., three levels of GA_3 (50, 75 and 100 ppm) and four levels of NAA (40, 60, 80 and 100 ppm) along with distilled water considered as control. The varieties Krishibid Hybrid-1 and Atlas-70 were used in 2015-16 and 2016-17, respectively. Foliar spray of GA_3 and NAA was given at 25 and 45 days after transplanting of seedling. The results of the investigation indicated significant differences among the treatments on most of the parameters studied. In Krishibid Hybrid-1, application of GA_3 50 ppm and NAA 60 ppm increased plant height, plant spread, number of leaves, chlorophyll content, quantum yield of Photosystem II (Fv/fm), head height, head diameter, single head weight without unfolded leaves as well as head yield (81.18 t/ha and 78.57 t/ha) than the control (67.29 t/ha) and other treatments. But, in

Atlas-70, application of GA_3 75 ppm gave the maximum values of most of the growth parameters, yield components and yield (102.40 t/ha), closely followed by GA_3 50 ppm (94.96 t/ha). The maximum average head yield (over two varieties) was obtained from the application of GA_3 75 ppm (88.84 t/ha) closely followed by GA_3 50 ppm (88.04 t/ha). Application of GA_3 75ppm, GA_3 50 ppm and NAA 60 ppm yielded 88.08, 88.07 and 82.92 t/ha, respectively which was 21.42%, 20.73% and 15.81%, respectively over control (69.81 t/ha). Application of GA_3 50 ppm recorded the maximum benefit-cost ratio of 4.01. From the point of economics, it is thus inferred that the use of GA_3 at 50 ppm concentration could be recommended for increasing the yield of cabbage with maximum return.

Effect of GA_3 and main head removal on seed yield and yield attributes of broccoli

The experiment was conducted at the field of plant physiology section of HRC during the *rabi* season of 2016-17. The experiment was laid out in Randomized Complete Block Design. The treatments consisted of four GA_3 concentrations (Factor-A) viz. G_0 = Distilled water (control), $G_1 = GA_3$ 60 ppm, $G_2 = GA_3$ 80 ppm and $G_3 = GA_3$ 100 ppm and two head removal treatments (Factor-B) *viz.*, R_0 = no head removal and R_1= Head removal at marketable stage. The unit plot size was 2.00 m x 1.80 m (3.6 m^2) having 12 plants. The variety used in the experiment was BARI Broccoli--1. Twenty eight day-old seedlings were transplanted on 27 November, 2016 adopting a spacing of 60 cm x 50 cm. The PGR GA_3 was sprayed to the plants at 50 and 75 days after transplanting mixing with 2-3 drops of Trix solution. Recommended doses of fertilizer were applied. Head harvest was done at marketable stage from 19 January, 2017 to 27 January, 2017 according to treatments. Seed harvest was done on 28 March, 2016. Plant height, leaves/plant, length of the biggest leaf, width of the biggest leaf and plant spread were not significantly influenced by head removal treatments. The combination of GA_3 and no head removal (G_1R_0) gave the maximum plant height closely followed by all combinations except G_0R_0 and G_1R_0. The G_1R_0 combination produced maximum number of leaves/plant which was closely followed by the rest of the treatments except control (G_0R_0). The maximum plant spread was recorded from the combination G_1R_0 closely followed by G_1R1 and G_2R_0 ant G_0R_0 gave the minimum plant spread. Pods/plant, pod length, seeds/pod, 1000 seed weight, seed yield/plant and per hectare were found maximum from the spraying of GA_3 60 ppm and their values were minimum under control treatment. No head removal treatment gave higher primary (12.88) and secondary flower stalks/plant (125.63) than head removal treatment. On the other hand, head removal at marketable stage gave maximum pods/plant (828.81), seed yield/plant (16.23 kg) and seed yield (520.41 kg/ha). No head removal treatment produced 463.13 kg/ha seed yield. Therefore, head removal treatment gave 11% higher seed yield over control. This might be due to removal of main head, several numbers of secondary shoots (heads) were produced around the main stem and they were not so compact as main head and also got more space which decreased competition among the flower stalks and thus produced more seeds. In case of control plants (without main head removal), no secondary head was produced and the flower stalks produced from main head were more compact which increased competition among the flower stalks for space, thus normal development of seeds was hampered. The lower seed yield obtained from no head harvested treatment could be also due to poor aeration and poor pollinator movement. Besides these, removed main heads at marketable stage were used as vegetable. This is an extra benefit which can be obtained from main head removal treatment.

Standardization of talc base formulation of *trichoderma viride* for disease management of cabbage

The experiment was conducted in Horticulture research field, BARI, Gazipur with cabbage (variety Atlas 70) for standardization of talc based formulation of *Trichoderma viride* and maize bran mixing ratio before application to control soil borne pathogens. Five ratio of talc *Trichoderma*: maize bran (1:2, 1:3, 1:4, 1:5 and 1:6) were tested. Control was maintained without any *Trichoderma* application. All *Trichoderma* treatment reduced disease incidence except 1:2. The highest disease incidence was recorded in control treatment. Talc *Trichoderma* and maize bran ratio 1:5 reduced the maximum disease incidence (62.23%) over control. Length and biomass of cabbage were not influenced by talc *Trichoderma* application. However, diameter, head weight and marketable yield were affected due to talc *Trichoderma* application. Cabbage diameter and single head weight was the highest in 1:5 ratio of talc *Trichoderma* and maize bran. Yield increased over control was 30.65 and 28.19% in 1:5 and 1:4 ratio of talc *Trichoderma* and maize bran, respectively. Considering disease incidence and yield 1:5 ratio of talc *Trichoderma* and maize bran mixing may recommend for soil application.

Bottle gourd

Varietal Impairment

Evaluation of new bottle gourd germplasm

The trial was conducted at the experimental field of Olericulture Division, Horticulture Research Center (HRC), Bangladesh Agriculture Research Institute (BARI), Gazipur during winter season of 2016-17. Five bottle gourd germplasm were included in the study to select superior lines with higher yield and better quality. The lines varied significantly ($P<0.05$) for their response to days to anthesis, fruit number per plant, fruit weight per plant, average fruit weight and fruit yield. The line LS 158 produced the maximum number of fruits per plant (14) as well as the maximum weight of fruits per plant (22.68kg). The fruit length ranged from 38.30 to 41.29 cm (LS 158), while fruit diameter ranged from 10.48 to 11.79 cm. The maximum fruit yield was recorded in the line LS 158 (45.37 t/ha) which was statistically similar with LS 154 (36.67 t/ha) while the lowest yield was found in the line LS 156 (23.43 t/ha). Considering earliness, higher yield, acceptable fruit size and shape, the line LS 158, LS 154, LS 153 and LS 155 were found promising and may put under preliminary yield trial.

Advanced yield trial of selected winter bottle gourd lines

The trial was conducted at the experimental field of Olericulture Division, HRC, BARI, Joydebpur during winter season of 2016-17. Five advanced lines of bottle gourd were included in the study to select superior lines with higher yield, better quality and maintain simultaneously increase the seeds of the selected lines. The lines varied significantly ($P<0.05$) for their response to fruit number per plant, average fruit weight (kg), fruit yield (kg/plant), fruit length (cm), fruit diameter (cm) and fruit yield (t/ha).The line LS151C produced the earliest fruiting with 85.17 days as well as the maximum number of fruits per plant (9.67). The range of fruit length was 19.70 (LS146 A1) - 47.37 cm (LS137 A5), while fruit diameter range was 10.45 (LS137 A5) - 16.89 cm (LS146 A1). The maximum fruit yield (t/ha) was recorded in the line LS151C (43.32 t/ha) which was statistically similar with LS139A1 (38.88 t/ha) and followed by LS137A5 (35.23 t/ha). Considering earliness, high yield, fruit color, acceptable fruit size and shape two advanced lines viz., LS 151C, LS 139 A1 were found promising and may selected for next year RYT.

Hybridization of bottle gourd lines

The study was conducted at the research field of Olericulture Division of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur during September 2016-17 to select superior cross combination of bottle gourd. Five cross combination of bottle gourd were included in this study. The hybrids differed significantly for most of the characters studied. Days required for 1st harvest range from 91 to 104 days, number of fruits/ plant, average fruit weight were 9 to14 and 2.10 to 2.49 kg, respectively and yield per hectare was 34.00-52.77 ton. Considering earliness, high yield, fruit color and acceptable fruit size, shape five combinations BARI Lau 3 X LS 139 A5, BARI Lau 4 X LS 139 A5, BARI Lau 4 X LS 139 A1, BARI Lau 4 X LS 151, and BARI Lau 3 X LS 137 A5 were selected for further evaluation as regional yield trial.

Cultural practice

Effect of plant growth regulators on vegetative growth, sex expression and yield of summer bottle gourd

Field experiments on bottle gourd (*Lagenaria siceraria* Molina) taking the variety BARI Lau -4 were conducted at the Plant Physiology Field of Horticulture Research Center, Bangladesh Agricultural research Institute, Gazipur during consecutive summer seasons of 2015 and 2016 to study the effect of plant growth regulators on growth, sex expression, yield and yield components of the crop. The experiment consisted of eight growth regulator treatments viz., GA_3 10 ppm, GA_3 30 ppm, NAA 100 ppm , NAA 150 ppm, MH 50 ppm, MH 150 ppm and CCC 500 ppm along with distilled water considered as control. All growth regulator treatments performed well in respect of all characters studied. Among all foliar agents, the response of MH, CCC and GA_3 was found better. Spraying of MH at 150 ppm gave the highest branches/plant and induced maximum female flowers at lower nodes in both the years followed by CCC 500 ppm in the first year and MH 50 ppm in the 2nd year. MH 150 ppm caused early appearance of female flowers on the nearest node (from bottom). Application of MH 150 ppm gave the lower number of male flowers/plant (82 in 2014 and 98 in 2015), the highest number of female flowers (37.3 and 40.00/plant in 15 1nd 16, respectively), thereby producing lower sex ratio and the maximum number of fruits (12/plant in 15 and 14/plant in 2016). Maximum fruit weight/plant was obtained from the application of MH 150 ppm (29.33 kg in 2015 and 35.83 kg in 2016) followed by CCC 500 ppm. The highest fruit yield per hectare was recorded significantly with the application of MH 150 ppm (97.62 t/ha and 89.58 t/ha in first and 2nd year, respectively) closely followed by CCC 500 ppm (88.52 t/ha in 2015) and GA_3 30 ppm (75.33 t/ha in 2016), as compared to other treatments and the lowest yield was obtained in control in both the years. The highest mean yield over the years was also recorded at MH 150 ppm (93.60 t/ha) followed by CCC 150 ppm (80.59 t/ha) and GA_3 30 (74.06). Application of MH at 150 ppm gave the maxim gross return and net return with the highest BCR of 6.24 followed by CCC 500 ppm (5.15) and GA_3 30 ppm (4.86).

Study of the dynamics of USG and prilled urea in relation to nitrogen supply and its effect on growth, shoot yield and nutrient uptake of bottle gourd

A pot experiment was conducted on bottle gourd (BARI Lau-4) at the research field of HRC, BARI, Gazipur, Bangladesh during *rabi* season 2015-16 and 2016-17 to find out the duration of N supply, its behavior and N use efficiency of plant from USG and PU and to study the growth patterns of the crop influenced by the USG and PU. The experiment was conducted followed by CRD with 3 replications. Five treatments were considered as T_1= without fertilizer (Native fertility); T_2= Recommended prilled urea (PU); T_3= Recommended urea super granule (USG); T_4=85% of recommended urea super granule (USG); T_5=70% of recommended urea super granule (USG). Nitrogen behavior and its effect on crop growth with USG and PU were significantly affected and although higher crop growth was occurred with PU in the initial growth stage but USG showed higher performance in plant height, leaves/plant, fresh shoot and root weight as well as dry shoot and root weight upto later development stages of crop. Maximum fresh shoot yield (1234 and 1573 g) was found in recommended USG (T_3) followed by 85% recommended USG (T_4) dose (1200 and 1531g) for the years, respectively. Higher branch/plant (13.0 and 10.69), flower/plant (31.3 and 76.33, respectively), SPAD value (49.97 and 50.90, respectively), soil N (0.130 at 75 DAT) and plant N content (2.74 at 75 DAT) were also found from USG treated plants than PU which indicated that USG supply N for a longer period of time than prilled urea for higher N uptake and plant growth. From soil-plant analysis it was also found the better response in soil and plant N content from USG as compared to prilled urea.

Use of tricho-compost and tricho-leachate for disease management of bottle gourd

Tricho-compost and Tricho-leachate have been producing at farmers' level in Jessore. Bottle gourd experiment was conducted at farmers' fields where the farmers' applied their own produced Tricho-compost and Tricho-leachate in the fields. Pheromone trap was used for insect control. Treatments were (i) Soil application of Tricho-compost @ 2.5 ton per hectare + chemical fertilizer 80% + foliar application of Tricho-leachate @ 20 ml/ liter of water and (ii) Farmers' practices (cowdung @ 2.5 t/ha + chemical fertilizers+ pesticides spray). Disease data were taken at harvest of fruits. Application of Tricho-compost reduced 41.67, 36.36, 16.67 and 30.0% in Urea, TSP, DAP and MoP fertilizers, respectively. Fruit rot reduced over farmers' practices was 48.67%. Marketable yield increased remarkable and yield increased over farmers' practices was 28.22%. BCR increased over farmers' practices was 24.30%.

Pumkin

Varietal Impairment

Evaluation of selected lines of pumkin for summer and winter

The study was conducted at Regional Horticultural Research Station (RHRS), Comilla in *rabi* and *kharif* season of 2016-17 to assess the performance in yield and yield contributing characters of new collected lines. A total of 18 (eighteen) germplasm of pumkin were collected from different areas of Comilla district. The line COMSG 18 gave the highest individual fruit weight (6.5 kg) and the highest yield was obtained from the line COM SG 1 (37.98 t/ha). This is the first year trial. So the study may be continued for the next year.

Screening of pumpkin germplasm against salinity at vegetative stage under pot culture

The pot experiment was conducted at the field of Plant Physiology Section, Horticulture Research Center, BARI during October 2016 to December 2016. Twelve genotypes of sweet gourd (G_1=1-1-1-6-4-2-6-2, G_2=31-2-4-12-3-7-5-7, G_3=75-2-1-5-3-6-3(B), G_4= BARI Hybrid Mistikumra-1, G_5=75-2-4-5-3-4-8, G_6=71-9(B)-1-1-2-2-5, G_7=75-2-1-5-3-7, G_8=71-9-6-9-10-3-9, G_9=5-4-12-6-3-9-3-3, G_{10}=BARI Mistikumra-1, G_{11}=75-2-1-5-3-4-12 (A) and G_{12}= BARI Mistikumra-2) collected from Olericulture Division of HRC, BARI. BARI Mistikumra-1 was screened out of 45 sweet gourd genotypes for the last two years. This variety performed better at 8 dS/m during germination and early seedling growth stage. The NaCl concentrations used were 0 (control), 4, 8 and 12 dS/m. The trial was non-replicated. Sweet gourd was grown in plastic pot (length 25 cm, dia 25 cm at the top and 12.5 cm at the bottom; capacity 10 L), which contained around 10 kg soil. The genotype G10 produced the maximum vine line length at 4 dS/m (60 cm) and 8 dS/m (48 cm) followed by G9 (48 cm at 4 dS/m and 37 cm at 8 dS/m) at 20 days after salt application. The genotypes G9 and G10 also produced vine length at 12 dS/m but other genotypes died. At 4 dS/m, the genotype G9 gave the maximum number of leaves/plant (19) followed by G1 (18), G10 (18) and G11 (16), and G12 produced the lowest (5). At 8 dS/m, maximum number of leaves per plant was obtained from G_{10} (18) followed by G9 (16) and G11 (12). At 12 dS/m, all the genotypes died accept G_9 and G_{10}. These two genotypes were alive after 20 days of salt application.. The genotype G8 produced the maximum CCI value (45.1) followed by G9 (41.7) and G10 (37.5) at 4 dS/m. At 8 dS/m, G9 gave the highest CCI value (37.9) which was followed by G10 (33.5). At 4 dS/m, the genotype G9 gave the highest root dry weight (1.49 g/plant) followed by G10 (1.22 g/plant) but, at 8 dS/m maximum root dry weight was recorded from G10 (0.68 g/plant) followed by G9 (o.65 g/plant). At 12 dS/m only G9 and G10 genotypes were alive. At vegetative stage, the genotype G10 gave the highest shoot dry weight (12.89 g/plant) followed by G9 and G12 gave the lowest shoot dry weight (4.2 g/plant) under control condition. Shoot dry weight decreased with the increasing salinity levels up to 12 dS/m in all the genotypes. The genotypes G9 and G10 produced maximum shoot dry weight in all saline treatments. All the genotypes except G9 and G10 died after 20 days of salinization. Genotypes differed in respect of total dry matter/plant (TDM/plant) (Fig. 6). The genoype.G10 gave the maximum TDM/plant (12.39 g/plant) followed by G9 (12.15 g/plant) at 4 dS/m. At 8 dS/m, G10 and G9 also produced the maximum TDM/plant. The two genotypes G_9 and G_{10} only produced greater than 80 percent RTDW at 4 dS/m. At 8 dS/m G9 and G10 produced greater than 70 percent RTDW. Relative total dry weight is very important comparision for saline tolerance among the genotypes. The study revealed that G9 (5-4-12-6-3-9-3-3-1) and G10 (BARI Mistikumra-1) were found to be better than other genotypes at salinity levels up to 12 dS/m at vegetative stage with regard to vegetative growth, chlorophyll content index, root and shoot dry weight/plant, and total dry matter/plant. Therefore, it might be concluded that the genotype G9 and G10 are salt tolerant.

Response of pumpkin to urea super granule (USG), prilled urea and pks fertilizer application

The experiment was conducted sweet gourd (BARI Hybrid pumpkin-1) at the research field of HRC, BARI, Gazipur, Bangladesh during winter 2016-17 to develop a fertilizer recommendation both with prilled urea and USG with PKS fertilizer and to evaluate the performance of USG to prilled urea with PKS fertilizer in pumpkin production. The experiment was designed followed by RCBD with three replications. Seven treatments were considered as- T_1= $N_{80}P_{35}K_{75}S_{20}$ +$Zn_4B_{1.5}$ (N as prilled urea); T_2= $N_{80}P_{35}K_{75}S_{20}$ +$Zn_4B_{1.5}$ (N as USG); T_3= 20% higher NPKS than T_1 + $Zn_4B_{1.5}$ (N as prilled urea); T_4= 20% higher NPKS than T_1 + $Zn_4B_{1.5}$ (N as USG); T_5= 20% lower NPKS than T_1 + $Zn_4B_{1.5}$ (N as prilled urea); T_6= 20% lower NPKS than T_1 + $Zn_4B_{1.5}$ (N as USG) and T_7= Native fertility**.** It was revealed from the study that fertilizer doses with USG application has performed better in sweet gourd production and recommended dose of USG and PKS produced the maximum yield (29.55 ton/ha) followed by 20% less than recommended dose of USG and other fertilizers (22.50 ton/ha). Higher number of fruit/plant (5.7 nos) and fruit diameter (17.3 cm) were also recorded in the same treatment. But no significant difference was observed in flesh thickness of sweet gourd.

Bitter gourd

Varietal Impairment

Regional yield trial of advanced bitter gourd lines

Four advanced lines of bitter gourd were evaluated with one check variety BARI Karala 1 at different regional locations of BARI during the summer season of 2016 to select suitable lines for release as variety. Fruits/plant of test lines ranged from 18 - 45 over the locations while 28 - 34 at combined data. Check variety ranged from 10-28 over the locations and at combined data. Check variety had higher average fruit weight (AvFwt) (96-197.6g) than the lines across the locations and at combined data (161g). All the lines AVBG 1301, MC 117-1-3-3, 117-1-2-3 and THMC 143 performed more or less well for yield/plant at individual locations and combined data (2.9-4.9, 2.8-4.6, 1.2-2.4 and 2.6-3.8 kg respectively). Performance of three lines AVBG 1301, THMC 143 and BT 117-1-3 was good for yield/hectare across the locations and combined data (9.2-30.7, 7.7-20.7 and 18.6-22.2 tons respectively) compare to check variety (6.7-18 tons). No infection of virus disease (0.0% virus incidence) was recorded in two lines (MC117-1-3-3 and MC117-1-2-3)and lower (16.7%) in two lines (THmc143, AVBG1301) while maximum in the check variety (38.9%).Based on the quantitative characters; visual observation of fruit color, shape and size; and virus reactions three lines MC 117-1-3-3, THMC 143 and AVBG 1301 may be proposed for releasing as OP variety of bitter gourd.

Combining ability and heterosis study in line x tester crosses of bitter gourd

The experiment involving eight inbred lines and four testers was conducted to evaluate inbred, and to determine general combining ability (GCA) and specific combining ability (SCA) effects in the research field of Olericulture Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during March to October 2016. Analysis of variance (ANOVA) based on the mean square of different characters revealed significant differences between the genotypes, parents and parent versus crosses for most of the traits studied. The proportional contribution of lines towards the total variance was higher than that of testers and line × tester interactions for most of the traits. Based on the gca effects and mean performances, female parent line-1, line-2, line-4, line-6, line-7 and tester-

1, tester-2, tester-4 were identified as good general combiner for most of the yield attributing characters like number of marketable fruits per plant, fruit length and yield per hectare. Based on the sca effects and mean performances, combination of Line-3 × Tester-4, Line-4 × Tester-2, Line-6 × Tester-2, and Line-7 × Tester-4 were found superior for yield components and selected for using in future breeding program.

Regional yield trial of bitter gourd hybrids

Performance of four bitter gourd lines viz. 117-1-3-3, 117-1-2-3, AVBG 143 & AVBG 1301 and BARI Korola-1 as check were evaluated for yield and yield contributing characters at Regional Agricultural Research Station, Ishurdi, Pabna during kharip season of 2016. Significantly highest number of fruits per plant (35) and yield (22.20 t/ha) was obtained from 117-1-3-3 and the lowest yield (6.72 t/ha) was obtained from BARI Korola-1. Fruit infestation by fruit fly was ranged from 3.7-15.76% and the highest infestation (15.76%) was recorded from AVBG 1301 and lowest (3.70%) from 117-1-2-3. On the other hand, number of virus infected plant was maximum (38.89%) in BARI Korola-1 and no virus infection was found in 117-1-3-3 and 117-1-2-3.

Postharvest quality and marketable life of bitter gourd as influenced by maturity stages

A study was done to investigate the influence of maturity stages on postharvest quality and marketable life of bitter gourd. It was conducted at Horticulture Research Centre (HRC) of Bangladesh Agriculture Research Institute (BARI) during March to August in 2016. Bitter gourd var. BARI Karola-1 was used in this trial. The plants were grown in the field following recommended production practices. The fruits were harvested at different days after anthesis (DAA), considered as selected maturity stages and designated as 10DAA, 12DAA, 14DAA, 16DAA, 18DAA and 12DAA. In this study, the best quality fruits were obtained from the harvest at 14DAA. The fruits of this stage attained 150.80 g in weight, 24.10 cm in length, 3.14 cm in breadth and 16.30 cm in circumference comprised with higher firmness (1.13 kg-F). They got higher preference scores for size and shape, tenderness, peel colour and bump appearance (8.4, 8.0, 8.4 and 8.6, respectively) at harvest. They retained the acceptability scores and firmness satisfactory above 3 days of storage. The minimum weight loss of 13.94% was recorded for the fruits harvest at 14DAA. The incidence and severity of quality defects viz. softening, yellowing, splitting and decay were also less in the fruits of 14DAA and 16DAA. Fruits harvested at 14DAA obtained higher marketability scores at harvest. It retained marketable value up to 3.50 days. Considering quality and marketable life of the fruits, the best commercial stage of harvest maturity of BARI Karola-1 was 14DAA.

Hyacinth bean

Varietal Impairment

Evaluation of hyacinth bean germplasm

An experiment was conducted at the research field of Regional Agricultural Research Station of Bangladesh Agricultural Research Institute (BARI), Jamalpur during the winter season of 2016-17 to evaluate the yield and yield contributing characters of six hyacinth bean germplasm. The bean lines viz., CB Jam-001, CB Jam-002, CB Jam-003, CB Jam-004, CB Jam-005 and CB Jam-006 were considered as materials, while, BARI Sheem-1, BARI Sheem-6 and BARI Sheem-7 were used as check. Data on different parameters were recorded and the results of major characteristics revealed that: the maximum number of pod per plant (566.00) was counted from the line CB Jam-003 and the minimum number of pod (149.53) was obtained from the line CB Jam-002. The highest average pod weight was recorded in CB Jam-006 (11.67 g), while the lowest pod weight received from the line CB Jam-003 (6.97 g). The maximum pod yield per plant (4.67 Kg), per plot (18.69 Kg) and per hectare (20.77 t/ha) and the minimum per plant yield (1.20 Kg), per plot (4.79 Kg) and per hectare (5.33 t/ha) recorded from the lines CB Jam-001and BARI Sheem7, respectively. Considering yield and yield contributing characters, the line CB Jam-001, CB Jam-004 and CB Jam-005 were found promising. This is the 1st year findings, therefore, experiment may be continued with selected lines for further evaluation for confirming the results.

Advanced yield trial of selected early hyacinth bean lines

The study was conducted of two selected early hyacinth bean lines with check variety BARI Sheem1 and BARI Sheem-7 at the research farm of Olericulture Division, Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the winter season of 2016-17 to assess the yield potentiality. The lines differed significantly on the most of the parameters studied. In case of days to 50% flowering, the line CB 0188 produced early flower (70 days) followed by the line CB 0160 (81 days), while the check variety BARI Sheem-1 needed longer times for 50% flowering (145 days). The maximum number of pods per plant (694) was exhibited by the check variety BARI Sheem-1which was statistically similar with the line CB 0188 (496). Pod weight per plant was the highest in BARI Sheem-1 (5.38 kg), which was statistically similar with line CB 0188 (3.67 kg), CB 0160 (2.99 kg) and BARI Sheem-7 (2.63 kg). BARI Sheem-1 gave the highest pod yield (14.52 t/ha) followed by CB 0188 (9.90 t/ha). Considering earliness the lines CB 0188 and CB 0160 may be selected for Preliminary yield trial (PYT) to develop early high yielding hyacinth bean variety.

Evaluation of yard long bean lines

The study was conducted at the research farm of Olericulture Division, Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the Kharif season of 2016 to evaluate the yield and yield contributing characters of eight yard long bean germplasm including BARI Borboti 1 as check. The lines including check variety differed for their response to all the traits. In case of days to 50% flowering the line VS 49 and BARI Borboti 1 exhibited early flower (39 days), followed by the lines VS 19, VS 20, VS 21 and VS 43 (40 days), while lines VS 09 and VS 32 (42 days) flowered late. The highest number of pods per plant was obtained from the line VS 43 (34.75), while the lowest was recorded the from line VS 49 (4.42). The line VS 43 produced the maximum weight of pods per plant (355 gm) and the line VS 49 produced the minimum (66.67 gm). The highest yield was obtained from found from the line VS 43 (19.72 t/ha) followed by BARI Borboti 1 (16.02 t/ha), VS 46 (14.44 t/ha) and VS 21(10.49 t/ha) whereas the lowest yield was recorded from the line VS 49 (3.70 t/ha). Considering quantitative characters, color and shape the lines VS43, VS46, VS21, VS19, and VS20 were found promising and putting into advance yield Trial (AYT) in the next years.

Regional yield trial of french bean lines

An experiment was conducted to assess the yield performance and adaptability with an advanced french bean line PVRai005 (khaishya) with check variety BARI Jharsheem 3 at four different location of Bangladesh Agricultural Research Institute (BARI) research stations during the winter season of 2016-17. The advanced line PVRai 005 and the check variety BARI Jharsheem 3 produced similar seed yield (4.95 t/ha and 4.92 t/ha respectively). Wide variation was observed over the locations in respect of green seed yield per hectare. On an average the advanced line PVRai 005 produce higher yield (4.97 t/h) which was followed by check variety BARI Jharsheem 3 (4.31 t/h) in Akhbarpur. Among the locations, at Hathazari, advanced line and check variety showed the best yield potentiality (7.76 t/h and 8.10t/h respectively). Moreover, the color, shape and attractiveness of the bold seed of the advanced line is superior than the check variety. Therefore, the experiment may be repeated for confirming the results.

Evaluation of garden pea germplasm

Six promising lines of garden pea collected from different sources, Gazipur were tested against BARI Motorshuti-3 at Olericulture Division, Joydebpur, Gazipur during November 2016 to March 2017 to develop bold seeded garden pea variety with high yield potentiality. Early flowering within 44 days was recorded in the lines PS0013 and PS0014, while the maximum days was required (61 days) in BARI Motorsuti-3. Minimum days (49 days) were required for pod formation in the line PS 0014 and BARI Molorsuti-3 formed pod after 65 days. The Highest number of pods per plant (35) was counted from the line PS0013 followed by PS0014 (32) and the lowest number of fruit (18) was recorded in BARI Motorsuti-3. The maximum weight of single pod (6.2 g) was observed in PS0014 while the minimum weight of single pod (4.4g) was weighed in BARI Motorsuti-3. The line PS0013 produced the highest pod yield (7.81 t/ha) followed by PS0014 (7.23 t/ha), while PS0011line produced the lowest pod yield (3.56 t/ha). Considering the yield potentiality, the lines PS0013, PS0014 and PS0015 were found promising. Therefore, an advance yield trial (AYT) may be conducted with selected garden pea lines in the next year.

Influence of different levels of potassium on nodulation, yield, quality and nutrients uptake of garden pea

An experiment was conducted in the research field of HRC, BARI, Gazipur, Bangladesh during Rabi season of 2016-17 to estimate the suitable doses of potassium for nodulation, quality and yield maximization of garden pea (BARI Motorshuti-3). There were 5 treatments viz. T_1 = Control, T_2 = 30 kg K ha^{-1}, T_3= 40 kg K ha^{-1}, T_4= 50 kg K ha^{-1} and T_5= 60 kg K ha^{-1} along with the blanket dose of $N_{15}P_{20}S_{10}Zn_3B_2$ kg ha^{-1}. The experiment was laid out in randomized complete block design with three replications. The results revealed that the green pod yield of garden pea ranged from 3447-4733 kg ha^{-1} and seeds yield varied from 755-1112 kg ha^{-1}. The highest green pod and seed yields (4733 kg ha^{-1} and 1112 kg ha^{-1}) was found in T_5 treatment and the lowest both yields were found in K control plot. The maximum nodulation and protein content (18.4%) was calculated from T_5 treatment. The greatest net return (Tk. 198385 ha^{-1} for green pod and Tk. 50695 ha^{-1} for seed yield) was counted from the treatment T_5. The maximum benefit cost ratio of 6.18 for green pod yield and 2.33 for seed yield of garden pea both were counted from the treatment T_5 followed by T_4 and the lowest were in T_1 treatment. Considering the yields, quality and economic, the application of 60 kg or 50 kg K ha^{-1} may be sound and suitable dose for garden pea yield maximization in grey terrace soils of Gazipur, Bangladesh.

Survey and morphological characteristic study of white mold pathogen in country bean

A survey was conducted on white mold disease in country bean at Bogra, Pabna, Jessore, Sylhet, Hobiganj and Gazipur during 2016-17. One upazila from each of the districts was selected. A total of 115 fields were surveyed at early vegetative to end of harvesting stage. Pathogen was collected from disease infected plant parts, twig, raceme and pod. All the visited fields (100%) were disease infected at Shahjahanpur in Bogra district. While about 90, 80, 60 and 20% fields were disease infected in Bahubal, Hobigonj; Golapgonj, Sylhet; Ishurdi, Pabna and Monirampur, Jessore, respectively. None of the field was disease infected in Joydebpur, Gazipur. Disease incidence was higher in Shahjahanpur, Bogra (65- 90%) and Bahubal, Hobigonj (55- 75%). Moderate disease incidence was found in Golapganj, Sylhet (40- 50%) and Ishurdi, Pabna (35- 45%) and it was lower Monirumpur, Jessore (10-15%). Pathogen infection was higher in loamy fine sand with lower pH (5.11-6.22). After rainfall the sclerotia were germinated and produced apothecia in the field. Hyaline, branched, well developed and septate mycelium was developed on potato dextrose agar media. After five days of incubation, the subsurface mycelial cells swelled, pigmented and formed the dark black sclerotia. The size of sclerotia was 1.5- 6mm in width and 2-17 mm in length. Sclerotia germinated, and brown round to globose shape apothecia was developed at the end of long stripe on wet sand media. The length and diameter of apothecia collected from field was about 4- 21 mm and 2- 8 mm, respectively. Asci were hyaline and cylindrical in shape, while the ascospores were elliptical. The size of ascus and ascospore were 68-155 x 4.5-6.01 μm and 4.7-6.94 x 4-6.2 μm, respectively. By-pyramidal hyaline crystal formation was observed on the wall surface of the asci.

Survey and monitoring of soil physico-chemical and environmental factors that influence white mold disease of country bean

a. **Effect of physico-chemical properties on *Sclerotinia sclerotiorum* infection in the fields:** Soil samples were collected from disease infected country bean fields in different survey areas of six districts viz.: Shahjahan-pur, Bogra; Moniram-pur, Jessore; Ishurdi, Pabna; Golapgonj, Sylhet; Bahubal, Hobigonj and Joydebpur, Gazipur. Soil texture was loamy find sand, pH was 5.11 (slightly acidic), organic matter content was 1.226% and total N content was 0.058% in Shahjahanpur, Bogra. Texture was sandy loam, pH was 5.84 (slightly acidic), organic matter content was 1.606% and total N was 0.145% in soil collected from Bahubal, Hobigonj. In Golapgonj, Sylhet, soil was loamy find sand and pH was 6.22 (slightly acidic), organic matter content and total N content was 1.636 and 0.0.145%, respectively. Soil sample collected from Monirampur, Jessore was sandy loam and pH was 7.87 (Calcarious), organic matter content and total N content was 1.407 and 0.072%, respectively. While soil collected from BARI, Joydebpur, Gazipur was silty clay loam and pH was 7.21 (Almost nutral), organic matter content and total N content was 0.931 and 0.054%, respectively. Soil texture was silty loam and pH was 7.4, and soil organic matter and total N content was 1.240 and 0.06%, respectively. Higher incidence of disease was recorded in Bogra (65- 90%) followed by Hobigonj (55- 75%) and Sylhet (40- 50%). It could be inferred that sandy loam to loamy fine sand with lower pH (slightly acidic) in Bogra, Hobigonj and Sylhet may influence disease development. Moreover, Ca contained in these three districts was lower (2.3 to 3.2) compared to other districts.

b. **Environmental factors influence on sclerotia germination and infection in the fields**: A highly disease infected field was selected for the study. Temperature (maximum & minimum), rainfall and humidity were compared whether it influenced sclerotia germination and apothecia formation or not. At the end of January, huge amount of sclerotia (4-5/ m^2) fallen down to soil from dry stem in disease infected fields. In first week, sclerotia started to germinate in irrigated soil and the maximum apothecia were developed in 4^{th} week of March with 20.79-29.41^{0}C. It may be due to rainfall in 3^{rd} week that may enhance sclerotia germination and apothecia formation.

Effectiveness test of bio-control agents against *sclorotinia sclerotiorum* of country bean *in vitro*

Some selected bio-control agents such as three fungal antagonistic viz. *Trichoderma harzianum, T. viride and T. virens,* and five bacterial antagonistic viz. *Bacillus subtilis* B20, *B. subtilis* B18, *Bacillus subtilis* BVC38, *B. amyloliqufaciens* Egg 25, *Pseudomonas* sp. (N) and *Pseudomonas* sp. (S) were examined for its effectiveness to control white mold pathogen caused by *Sclerotinia sclerotiorum* on sterilized standard potato dextrose agar media following Duel Culture Technique. The lab experiment was arranged following completely randomized block design with 4 replications. The radial growth was measured from central loci of pathogen when it touches at edge of petri-plate in control treatment. At the same time intermingled and inhibition zone development was observed between pathogen and antagonistic bio-control agents in treatment plate and the radial growth pathogen towards bio-control agents were also recorded. For both groups of antagonistic agents the assessment was made after 7 days of incubation. The radial growth of *S. sclerotiorum* reduced remarkable in presence of *Trichoderma viride, T. harzinum, Pseudomonas* sp (S), *Pseudomonas* sp. (N) and *Bacillus subtilis* BVC38. Mycelium growth inhibition was 95.33, 94.96, 93.67, 93.42 and 92.25% in *Trichoderma harzianum, T. viride, Pseudomonas* sp. (S), *Pseudomonas* sp. (N), and *Bacillus subtilis* BVC38, respectively.

Others

Varietal Impairment

Evaluation of YVMV tolerant okra germplasm

An experiment was conducted at Regional Agricultural Research Station (RARS), Jessore during kharif season of 2016. The okra lines viz.: LF Jes-001, LF Jes-002, LF Jes-003, LF Jes-004 and LF Jes-005 were tested. However, the okra line LF Jes 001 yielded the highest (11.49 t/ha) followed by the line LF Jes 002 (10.47 t/ha) and the lowest yield was obtained from the okra line LF Jes 003 (9.58 t/ha). In case of virus infection, the line LF Jes 002 infected in a lower rate by 44.44% followed by the line LF Jes 004 (80.55 %) at 80 days after sowing (DAS). Whereas, the highest infection (100 %) was recorded in the okra line LF Jes 003 followed by the lines LF Jes 001 and LF Jes 005 by 94.44 % each. This is first year result, therefore, the experiment may be repeated for confirming the results.

Regional yield trial of spinach lines

The study was conducted with two selected spinach lines with BARI Palongshak 1(check) at four locations which were included Joydebpur, Jamalpur, Jessore and Ishurdi during the winter season of 2016-17 to develop a late flowering variety of spinach. The seeds of two advanced spinach lines (SO-0047 and SO-0048) with BARI Palongshak1 were sown on 22 - November, 2017 maintaining 15 x 10 cm spacing in all locations. The line SO-0047 required average longest days (70.66) to 50% plant bolting followed by the line SO-0048 (66.66) while BARI Palongshak1 took the shortest days (57.0) to 50% bolting at all the location. The highest average per hectare yield of four locations (24.7 tons) was recorded from the line SO-0047 and the lowest average per hectare yield (20.33 tons) was recorded from BARI Palongshak-1. In case of qualitative parameter, the line SO-0047 produced medium size, light green colour, ovate shape and succulent large leaf with short petiole, while SO-0048 showed medium size, round shape deep green colour with short petiole but BARI Palongshak1 produced large round shape green colour succulent leaf with long petiole. SO, considering of late bolting nature and yield potentiality the line SO-0047 may be selected for releasing as a late variety of spinach.

Evaluation of stem amaranth lines

The study was conducted with 85 stem amaranth lines with check (BARI Danta-1) at the research field of Olericulture Division , HRC, BARI, Gazipur during Kharif 1 season of 2017 with a view to developing early winter and late summer and less fiber containing variety of stem amaranth. Out of 85 lines, 5 lines were leafy nature and 17 lines were similar in respect of leaf shape and colour and other 21 produced flowers at early stage (8-10 leaf stage). Based on earliness, yield potentiality, stem length and stem nature lines were categorized into three groups. Among 43 lines/ variety, plant height ranges from 38.60 to 99.30cm, leaf length (9.60-19.0cm), leaf breadth (5.0-12.60cm), individual stem weight (40.0-373.50g) and yield per hectare (8.0-55.99 t) were recorded. 16 lines required below 40 days to harvest, 17 lines required 40-50 days and 10 lines required more than 55 days to harvest. On the basis of yield per hectare, 23 lines produced less than 20 tons, 9 lines produced 20-30 tons and 11 lines produced more than 30 tons. In the case of growth nature, 7 lines showed short growth, 32 lines were medium growth and 4 lines showed tall growth. In the case of pigmentation; pink, red and green were identified. Branchless, few branches and all along branches these three characters were also observed. All the lines showed erect nature, stem were conspicuous. From the study it may be concluded that on the basis of qualitative and quantitative characters nineteen linesAM-0001, AM-0005, AM-0014, AM-0047, AM-0048, AM-0049, AM-0050, AM-0054, AM-0055, AM-0058, AM-0068, AM-0010, AM-0009, AM-0011, AM-0015, AM-0024, AM-0039, AM-0059, AM-0060 were selected for further evaluation.

Evaluation of selected lettuce lines

The experiment was conducted at the horticultural field of HRC, BARI, Joydebpur, Gazipur during Rabi season of 2016-17 to evaluate the yield performance of selected lettuce lines. Five lettuce lines with check (BARI Lettuce 1) were included in trial at. Variation was observed among the advanced lines in respect of yield and yield contributing characters. Number of leaves/plant varied significantly among the lines. The maximum number of edible leaves per plant was counted from the line LS-0014 (12) and the minimum were recorded from LS-0012 (9.86). The highest marketable leaf yield was obtained from the check variety BARI Lettuce 1 (18.63 t/ha) followed by LS-0012 (16.04 t/ha) and the lowest yield was obtained in LS-0011 (13.26 t/ha). The most of the lines produced light green to deep green colored leaves. The lettuce line LS-0011 produced attractive maroon colored leaves and produced seed in local climatic condition. Considering marketable yield, leaf color and seed producing ability, the lines LS 0011 and LS 0007 may be selected for advanced yield trial in next year.

Evaluation and conservation of indigenous vegetables

Twenty eight types of underutilized indigenous vegetable (12 vegetable and 16 medicinal) were put under observational trial to assess their performance in respect of yield, seed production and agronomic practice for growing different time of the year during 2016-17. The yield potentiality of Bathua - green (17.32 t/ha), Bathua - red (19.70 t/ha), Thankuni (1.60 t/ha), Nafa Shak (5.20 t/ha), Pudina (3.15 t/ha), Nunia (16.75 t/ha), Malancha (7.90 t/ha), Helencha (5.60 t/ha), Shialmutra Shak (16.85 t/ha), Shaknotey (21.30 t/ha), Katanotey (23.10 t/ha) and Pat Shak (1.25 t/ha). Effort on growing of telakucha (Reshmato - *Coccinia cordifolia*) through seed and vine cutting at three times of the year was under trial. It was observed that means of propagation as seed was not feasible but vine cutting as means of propagation was suitable for year round production of telakucha. However, further studies are required for the standardization of their production practices.

Evaluation and characterization of drumstick germplasm

A study on collection and evaluation of drumstick germplasm was conducted at the experimental field of Olericulture Division of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the season of 2010-11 to onward and this year (2016-17), a study on evaluation of selected seven drumstick lines was conducted. The drumstick line: MO 0025 found to be as seasonal natured having good quality with individual pod weight (61.53 g), while four lines viz., MO 0001(1), MO 0007, MO-0008, MO-0011 and MO-0012 were considered as off-seasonal promising lines having 40-50 g, average individual pod weight. Yearly average per plant yield indicated that the lines MO 0001(1) exhibited the maximum yield (12.75 kg) followed by line MO 0012 (13.23 kg) and line MO 0011. These lines were capable to produce flower two to three times in a year. No major pest and diseases found to be attacked in the moringa lines. The experiment with selected lines may be repeated for confirming the results and increasing mother plants in next year for future use.

Effect of growing media on the growth of vegetable seedlings

Seedling quality of summer tomato grown under different growing media were evaluated in this experiment at the Olericulture farm of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the season of 2016-17 in order to raise ideal and healthy seedling. Seven growing mediums were M_1= soil : cowdung : rice hull (2:2:1), M_2= soil : vermi compost: rice hull (2:2:1), M_3= soil : cowdung : coco dust (2:2:1), M_4= soil : vermi compost: coco dust (2:2:1), M_5= soil : cowdung : ash (2:2:1), M_6= soil : vermi compost: ash (2:2:1) and M_7= soil : cowdung (1:1) as control. Each treatment was replicated three times following randomized complete block design. Results indicated that soil added with cowdung and cocodust (2:2:1) filled in polybag produced the highest seedling height (18.8 cm), greater stem diameter (4.26 mm), the highest number of leaves (11) per seedling and the highest (142.45 cm^2) leaf area at 25 DAS. The highest value of seedling vigor index (418) as well as the highest seedling quality index (1.05) also observed in the same treatment. Therefore, soil, cowdung and coco dust at the ratio of 2:2:1 may be suggested to raise good and healthy tomato seedlings.

Evaluation of urea super granule (USG) technology for upland vegetables at different locations of Bangladesh

The experiment was conducted on cabbage (var. Atlas 70), cauliflower (Hybrid F_1- SiraGiKu); broccoli (Premium crop); tomato (BARI Tomato-14) and eggplant (BARI Bagun-4) in the location HRC, BARI, Joydebpur, Gazipur, Bangladesh only in 2015-16 and Joydebpur and four other location of Bangladesh as Akbarpur, Moulvibazar, Jamalpur, Burirhat, Rangpur and Jessore in 2016-17 cropping season followed by RCB design with 3 replication to evaluate the location specific performance of USG technology to popularize and adoption by the vegetable growers; to reduce cost of production through minimum use of urea fertilizer and to improve vegetable production and farmer's income. Two treatments were selected as T_1= Prilled urea (PU) and T_2= Urea super granule (USG). In 1st year it was conducted with three crops as cabbage, cauliflower and broccoli but two more crop as tomato and eggplant were added in the year 2016-17. Maximum yield of cabbage (116.248-119.442 t/ha), cauliflower (46.049-48.086 t/ha), broccoli (12.617-16.235 t/ha), tomato (140.137 t/ha) and eggplant (41.274 t/ha) were obtained in USG treatment in Joydebpur. From two years results it was observed that USG is more profitable than PU both in respect of yield and economic profitability for all the locations under study. So, USG technology is more viable for the production of upland vegetables like cabbage, cauliflower, broccoli, tomato and eggplant.

Effect of different model of rooftop garden for vegetables production

The study was conducted at roof top of Mushroom laboratory, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during July 2016 to June 2017. Nine Treatments viz., T_1= Plastic box 1, T_2= Plastic box 2, T_3= Plastic box 3, T_4= Plastic box 4, T_5= Plastic box 5, T_6= Plastic box 6, T_7= Plastic box 7, T_8= Half drum and T_9= Sac/ Multilayer box and three roof top garden models viz., Model 1, Model 2, Model 3 were included in the study. Each model consists of 22 type vegetables. Considering the 3 models, there were a narrow difference in term of vegetable yield and prices. The main cause behind it was the number of vegetables were same (22) in all models. Just rearrange the vegetables within the treatments and type of production system viz., single cropping, inter cropping and relay cropping. So, on a roof garden from a 10 m^2 / 100 ft^2 area, anybody may follow any model preferably Model 1 and Model 2, which vegetable price (2270 tk) and yield (73 kg) were higher, respectively. This study was just I-year result, so after another year trial it may be concluded which model is best in terms of yield and price.

Influence of sowing time based temperature on flowering and yield of french bean varieties

A field experiment was conducted at Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Moulvibazar during rabi season of 2016-2017 to evaluate the flowering behavior and pod yield of French bean. Three varieties namely BARI Jhersem 1, BARI Jhersem 2 and BARI Jhersem 3 were used in this stage and sown at November 30, December 15 and December 30 for getting temperature variation. The maximum pod yield was obtained from BARI Jhersem 1 sown on 30 November (13.51t/ha) and the lowest yield was obtained from BARI Jhersem 3 sown on 30 December (2.41t/ha).

Screening of spinach germplasm against salinity under pot culture

The pot experiment was conducted at the field of Plant Physiology Section, HRC BARI during December 2016 to January 2016. Eight genotypes of spinach (SO-0048, SO-0046, SO-0047, BD-4333, BD-4323, BD-4339, BD-1062, and BARI Spinach-1) collected from Olericulture Division of HRC, BARI were used in the study. The genotypes BD-4333, BD-4323, BD-4339, BD-1062, and BARI Spinach-1 were screened out of 21 spinach germplasm for the last two years. These five genotypes performed better at 8 dS/m during germination and early seedling growth stages. The NaCl concentrations used were 0 (control), 4 dS/m, 8 dS/m and 12 dS/m. The study was evaluated under

Completely Randomized design (CRD) with three replications. Spinach was grown in plastic pot (length 25 cm, dia 25 cm at the top and 12.5 cm at the bottom; capacity 10 L) which contained around 10 kg soil. In each pot, 10 seeds were sown on 27 December, 2016. The experiment ended in 30 January 2017. Significant variation among the genotypes was observed for plant height and number of leaves/plant. The highest plant height was found from BARI Spinach -1(26.20 cm) closely followed by SO-0048, SO-0046 and the lowest from BD-4339 at control. At 4 dS/m salinity level, BARI Spinach-1 produced the maximum plant height (25.67 cm) followed by SO-0048 and SO-0047 abd SO-0046 and the lowest from BD-4333. But at 8 dS/m and 12 dS/m, the genotype SO-0047 produced the maximum plant height followed by SO-0048. Nmber of leaves per plant was found maximum in BARI Spinach-1 (14) followed by SO-0047. At 8 dS/m, SO-0046, SO-0047 and BARI Spinach-1 produced the maximum but similar number of leaves/plant (8). But at 12 dS/m, maximum number of leaves per plant was obtained from the line SO-0047 (7). There was significant variation in root dry weight among the genotypes under control and saline condition and root dry weight decreased with the increasing salinity level up to 12 dS/m in all the genotypes. The genotype SO-0047 gave the maximum root dry weight at all salinity levels (4, 8 and 12 dS/m) followed by SO-BD-4323, SO-0046 and SO-0048.Shoot dry weight decreased with the increasing salinity level up to 12 dS/m in all the genotypes. The genotype SO-0047 gave the highest shoot dry weight at the salinity levels of 4, 8 and 12 dS/m (8.70, 5.73 and 3.40 g/plant), which was followed by BARI Spinach-1(7.97, 5.45 and 2.80 g/plant). TDM was dcreased gradually with the increasing salinity level and the genotype SO-0047 produced the maximum total dry matter/plant which was identical with SO-0046 and BARI Spinach-1 at 4 dS/m. TDM was found higher in control treatment in all genotypes . At 8 and 12 dS/m salinity level, the genotype SO-0047 produced the maximum total dry matter which was followed by BARI Spinach-1 and SO-0048. The two genotypes SO-0046 and BARI SPINACH-1 only produced greater than 80 percent RTDW at 4 dS/m and the genotype SO-0047 gave RTDM close to 80 percent. At 8 dS/m S)O-0047 and BARI Spinach-1 produced greater than 55 percent RTDW. These two genotypes also gave RTDM compared to other genotypes. Based on these results, it can be concluded that two genotypes SO-0047 and BARI Spinach-1 were found salt tolerant than other genotypes.

Effect of simple net houses on year roundvegetable production

Performances of four vegetable crops were observed under different net houses at the Olericulture farm of Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute, (BARI), Joydebpur, Gazipur during the season of 2016-17. Tunnel covered with net from top to bottom and tunnel covered with net from top to bottom with polythene cover at the top were considered two types of net houses compared with open field cultivation as control. Therefore there were three treatments which were replicated three times following randomized complete block design. Micro climate data showed that netting affected environmental variables. Photo synthetically active radiation (PAR) reduced in the net houses, on the other hand temperature and humidity increased marginally compared to open field. Growth and yield of tomato, capsicum, cucumber and spinach were observed under the treatments. Results indicated that tomato and spinach yielded lower (2.15 and 2.08 kg/plant, respectively) in net house cultivation compared to open field cultivation (3.14 kg/plant). But capsicum and cucumber performed better in respect of yield and yield contributing characters under net house.

Evaluation of different mushroom genotypes

Yield potentialities of five varieties of oyster mushroom were studied at the Olericulture Division, Horticulture Research Center, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the months of February-June 2017. The objective of this study was to evaluate the performance of different mushroom varieties and to select suitable ones with good yield and quality. A wide variation was observed in yield and yield attributes in different varieties. Among the varieties, The highest numbers of fruiting body was found in *Pleurotusdjamor* (Pop) followed by *Pleurotusflorida*(Flo) and the lowest number was found in *Pleurotusostreatus var.* white snow (Ws). Yield per packet was recorded the highest (290 g) in Pop followed by *Pleurotusostreatus*(Po) (260 g) and the lowest (160 g) in *Pleurotussajor-caju* (Psc). The variety *pleurotusflorida* (Fl) produced the largest sized fruiting bodies while *PleurotusSajor-caju* (Psc) produced the smallest ones.

Economics

Costs and returns database of horticultural crops

Costs and return database of nine crops, namely country bean, cabbage, brinjal, tomato, snake gourd, cucumber, chilli, bitter gourd and okra were collected from the secondary sources from the theses of Department of Agricultural Economics, BAU, Mymensingh. Highest BCR was found in brinjal (2.96) followed by cabbage (2.42), country bean (2.14), cucumber (1.82), okra (1.72), dry chilli (1.65), tomato (1.87), bitter gourd (1.58) and snake gourd (1.42). Highest net return was found in cabbage (Tk 331237/-) followed by brinjal (Tk 303,358/-), country bean (Tk 210962/-), tomato (Tk 159027/-), cucumber (Tk 152698/-), dry chilli (Tk 117827/-), okra (Tk 90018/-),bitter gourd (Tk 84874/-) and snake gourd (Tk 81033/-). Highest gross cost was also incurred in cabbage of Tk 233191/- followed by snake gourd (Tk 193106/-), cucumber (Tk 187238/-), country bean (Tk 185428/-), Tomato (Tk 181614/-), dry chilli (Tk 179766/-), brinjal (154,392/-), bitter gourd (Tk 147126/-) and okra (Tk 124992/-). It is observed that generally the crops incurring the higher cost gave higher return (correlation co-efficient 0.68).

Postharvest Management

Establishing and managing a model packhouse to link farms and markets for better price of vegetables

Model packhouse and value chain development were joint activities in developing one collection centre with packhouse operations like cleaning, sorting, grading, packing and other market preparation activities and direct marketing of vegetables. Different hardware requirements including sorting table, weighing balance, washing tank, plastic crates, cold room etc. were provided to the existing collection centre. Training of the farmer's group, traders and other value chain actors was provided for skilfully operating of the packhouse based on the technical operations and technologies for packhouse, record keeping and accounting, marketing and other business development skills. The value chain involving the model packhouse was improved by integrating postharvest technologies and best practices for fresh vegetables. Strong linkage was developed between farmer's groups and exporter for ensuring marketing the product with better price. With the use of packhouse facilities a total of about 250 MT cabbage and 15 MT cauliflowers were exported to Malaysia and Singapore through Chittagong sea port during December 2016 to March 2017. Thus, vegetable growers around the packhouse got lucrative price by directly selling their products to the exporters.

Comparison of blanching method between boiling water and microwave on the quality of frozen carrot

Microwave and boiling water blanching method were compared in this study in order to determine their effects on some quality characteristics of carrot just after blanching and during frozen storage. After blanching carrot pieces (1 cm^3) were cooled, packed in high density polyethylene bag and stored at -20°c. The effectiveness of each blanching process was performed measuring the lost of peroxidase activity, that results more rapidly in microwaves (1.5 min) than in boiling water (2 min). After blanching the colour values, lightness and chroma was increased and hue angle was decreased results more bright orange colour of carrot pieces. Ascorbic acid, total sugar, reducing sugar and TSS of carrot was reduced whereas beta carotene content was raised after blanching. In micro wave blanching (MWB), reduction of nutrients was lower than in boiling water blanching (BWB). During frozen storage, in unblanched carrot the quality was reduced significantly whereas in blanched carrot it was less especially in MWB one.

Hydroponic

Varietal Impairment

Year round production of selected vegetable crops through hydroponic culture

The experiment was conducted at the plastic house of Olericulture division of the Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during 2016-17 to assess the year round production feasibility. The growing season were T_1=Oct.-Jan., T_2 =Feb.-May and T_3=Jun-Sept. In cucumber, plant height were minimum in T_1 (175.87) cm and maximum in T_3 (190.20) cm. Minimum day's to1st female flowering was in T_3 (56days) and maximum in treatment T_1 (60.66 days). There was no significant difference in harvest among the three planting times. the maximum yield was obtain from T_3 (1.55 kg) and minimum in T_2 (1.15 kg). In case of bitter gourd plant heights were higher in T_2 (421.67cm) followed by T_1 (410 cm) and the lowest in T_3 (375.00 cm). Days to 1st female flowering open was earlier in T_3 (51.33 days) and late in T_2 (58.66 days) . There is no significance difference in harvest; first harvest is recorded from T_3 (60.73 days). No. of fruits/plant was higher in T_2 treatment (9.00) while lower from T_3 (8.00). Fruit length was higher in T_2 (18.36 cm) and lower in T_3 (16.56cm). The highest yield/plant was obtained from T_2 (2.27 kg), followed by T_1 (2.04 kg) and the lowest yield was obtained from T_3 (1.88 kg).

Dissemination of BARI developed hydroponic technology at different areas of Bangladesh

An experiment was conducted for the dissemination of BARI developed hydroponic technology at different areas of Bangladesh during 2016-17 to study the feasibility of hydroponic technology. In Dohar area tomato plant height ranged from 265-301 cm, Number of fruit per plant varied from 45-60, fruit length varied from 6.5-8.6 cm, fruit breadth ranged from 4.2 - 5.1 cm, fruit weight ranged from 75-85 g and yield per plant ranged from 3.53-4.9 kg. In Hazirpool, Baizid, Chittagong, the cherry tomato plant height range from 290-315 cm, Number of fruit per plant varied from 41-58, fruit length varied from 4.5-6.6 cm, fruit breadth was 3.8-4.3 cm, individual fruit weight ranges from 42-54 g and yield per plant ranged from 1.7-2.9 kg.

Observation trial of off season watermelon production in hydroponic culture

Observation trial on production of off season watermelon was conducted with the variety Black Diamond in circulating system of hydroponic culture at net house of RHRS, BARI, Lebukhali, Dumki, Patuakhali. It is revealed that the plant height of watermelon ranged from 175-189 cm, days to harvest varied from 72-90 days, no. of fruits per plant was 1-2. Single fruit weight ranged from1.44-1.75kg .Yield per plant was 1.72 kg.

Organic practices

Evaluation of tomato lines under organic practices

A total 33 tomato genotypes were evaluated at Olericulture Division of HRC, BARI, Gazipur during 2015-16 under low input organic condition including three checks (BARI Tomato-11, BARI Tomato-15, BARI Tomato-17) in order to find suitable genotypes for growing organically. The experiment was set in an augmented design and revealed that the genotypes were significantly differed ($P \leq 0.05$) in horticultural traits except 50% plants flowering and fruit shape. The crop duration were more than 3 months, while plant height ranged from 63.0 - 255.6 cm. Single fruit weight was varied significantly as cherry types genotypes were also included in the evaluation, and ranged 8.06-309 g. Number of fruits per plant was also significantly differed which was ranged 4-115. The fruits shape was observed round to elongate. The quality characters of the fruits namely, brix and shelf life were also varied significantly. The brix value recorded the maximum value was 6.99 and the minimum 2.33. Pericarp thickness found thick to thin. The per plant yield recorded the highest in the genotypes AVTO 1242-1 (5.01 kg), while the lowest in AVTO 1248-2 (0.39 kg). Considering the horticultural traits AVTO-1201-1, AVTO-1202, AVTO -1242-1, AVTO -1245 -2, AVTO 1250 -1, Cherry 2, Ind. Green, Ind. White, and H390 may selected for PYT under organic condition. Moreover, genetic reason may require identifying for future low input breeding purpose.

Effect of mineral fertilizer from natural origin in combination of Baofer on yield of tomato under organic practices

An experiment was carried out at organic block developed by matured poultry compost 15 t/ha/year at Olericulture Division under HRC, BARI to increase efficiency of organic fertilizer and product for growing tomato (BARI Tomato-15) during October 2016 to March 2017. Five fertilizer combinations, namely, Baofer 100 g + MF 0 g, Baofer 75 g + MF 5 g, Baofer 75 g + MF 0 g, Baofer 50 g + MF 5 g, Baofer 50 g + MF 0 g, and control (without Baofer and MF) per pit respectively. RCB design was followed with three replications. All treatment combinations were varied significantly. It was observed that Baofer 75 g with 5 g MF showed significant variation among the characters like, number of fruits per plant, individual fruits weight (g), °Brix and yield per plant (kg). Considering the results,Baofer 75 g in combination with 5 g MF may be applied to produce organic tomato. However, further study is required to confirm the result.

Evaluation of virus resistant summer tomato hybrids lines under organic practices

An experiment was carried out at organic block of Olericulture Division under HRC, BARI to find the suitable F1 genotypes of virus resistant summer tomato during May 2016 to October 2016has been developing by matured cowdung compost 15 t/ha/year. Five lines, CLN-3324A x CLN-3241AA, CLN-3324A x CLN-3125-O-19, CLN-3150-A-5 x CLN-3125-O-19, including two released varieties BARI Hybrid Tomato-4 and 8 were evaluated by applying hormone and without hormone. RCB design was followed with three replications. All treatment combinations were varied significantly. It was observed that application of hormone influenced the yield contributing characters, and quality of summer tomato genotypes. However, further study is required to confirm the results.

Effect of organic fertilizer on yield of tomato under organic practices

An experiment was carried out at organic block has been developing by cowdung compost 15 t/ha/year at Olericulture Division under HRC, BARI to increase efficiency of organic fertilizer and product for growing tomato (BARI Tomato-15) during October 2015 to March 2016. Five fertilizer combinations, namely, Compost 100 g, Vermicompost (VC) 100 g, Baofer 100 g, Baofer 50 g + Trichocompost 50 g, and control (none of organic fertilizer) per pit respectively. RCB design was followed with three replications. All treatment combinations were varied significantly. It was observed that Baofer100 g showed significant variation among the characters like, number of fruits per plant, individual fruits weight, °Brix and yield per plant. Considering the results Baofer100g may be applied to produce organic tomato while the main plot is fertilized only with 15 t/ ha matured cowdung compost. However, further study is required to confirm the result including other crops.

Impact study of organic practices

A study was carried out among the organic, semi-organic (use organic fertilizers and biorational pest control method) and chemical farmers at three different locations (Gazipur, Mymensingh and Jhenaidah) of the country comprising 20 farmers of each group and each locations. The aim of the study was to assess the productivity, income and overall performance and impact on the soil organic farm and of the organic agriculture in the farming community.

7 FRUIT CROPS

Project I: Varietal Development

Evaluation of jackfruit germplasm

An evaluation of eleven jackfruit germplasm was done at the Fruit Research Farm of HRC, BARI, Gazipur. Collected jackfruit germplasm were planted in the Fruit Research Farm of HRC, BARI, Gazipur in July 2001. Planting distance was maintained as 5.7 x 2.8 m. Wide range of diversity was observed in number of fruits per plant, fruit characters and pulp characters of jackfruit germplasm. Variation in number of fruits (8 to 54) was observed. Maximum number of fruits was recorded in AH Joy-075 and minimum in AH Joy-039-2 and AH Joy-104. Fruit characteristics of jackfruit germplasm also varied largely. The fruit weight ranged from 3.28 to 7.55 kg. Number of bulb per fruit varied from 25 to 185. Maximum fruit length (36.0 cm) was observed in AH Joy-078 and minimum (22.1 cm) in AH Joy-110. The fruit breadth ranged from 17.2 to 22.6 cm. The pulp of most of the germplasm was soft and light yellow. The length of the bulb ranged from 4.2 to 9.0 cm and width from 2.5 to 4.2 cm. The bulb shape was rectangular, irregular, twisted, oblong and spheroid. TSS was noticed to vary from 14.5 to 20.0 ^{o}Brix. Out of 11 jackfruit germplasm at Gazipur, four germplasm; one early (AH Joy-075, harvested in April), one late (AH Joy-078, harvested in mid July), two mid season (AH Joy-073-2 and AH Joy-110, harvested in June) germplasm performed well in respect to number of fruits, fruit weight, edible portion, TSS and pulp quality.

Evaluation of jackfruit germplasm

Five jackfruit germplasm of various ages (9-30 years) were evaluated at RARS, BARI, Jamalpur. Wide range of variability was observed in plant and fruit characters. The highest number of fruits per plant was observed in AH Jam-03 (85) and the lowest number of fruits per plant was observed in AH Jam -08 (41). Maximum TSS was obtained from the germplasm AH Jam -03 (21%) and minimum from TSS was obtained from AH Jam-08 (16%). The highest edible portion was recorded in AH Jam-02 (62.87 %) as against the lowest edible portion in AH Jam-23 (38.73 %). Among the five germplasm, AH Jam-02 was observed to bear fruit twice a year (June to July and March).

Evaluation of off season jackfruit germplasm

Three selected off-season jackfruit germplasm were evaluated at RARS, Akbarpur, Moulvibazar. The date of first harvesting was recorded 03-03-2017 in AH Akb-001 which was followed by 16-03-2017 in AH Akb-017 and 19-03-2017 in AH Akb-008. The highest number of fruit was observed in AH Akb-001 (110) followed by AH Akb-008 (40) and AH Akb-017 (40). Maximum percent of edible portion was noted in AH Akb-001 (38.82%) which was followed by AH Akb-008 (32.25%) and AH Akb-017 (33.33%). The highest TSS was recorded in AH Akb-001(30.75%) followed by AH Akb-008 (21.0%) and AH Akb-017(24.0%).

Evaluation of jackfruit germplasm in the hill region

Evaluation of eleven jackfruit germplasm was done at the fruit farm of HARS, Khagrachari with the objective of identifying superior small sized jackfruit with high yield potentiality and edible qualities. Number of fruits per plant ranged from 33-121. Maximum number of fruits was recorded in AH Kha-

004 (121) followed by AH Kha-002 (103) and minimum number of fruits was recorded in AH Kha-009 (33). Among the eleven, six germplasm produced more than 75 fruits per plant indicating high yield potentiality. Single fruit weight ranged from 2.65-4.63, where AH Kha-003 produced the highest (4.63 kg) individual fruit weight followed by AH Kha-001 (4.59 kg) and the lowest fruit weight was noticed in AH Kha-009 (2.65 kg). TSS content of the fruit varied from 17-23%, whereas the highest TSS (23%) was performed in AH Kha-005 and AH Kha-010. Maximum fruit yield was observed in AH Kha-004 (453.75 kg) and minimum fruit yield was noted in AH Kha-009 (87.45 kg). The edible portion varied from 32.83 to 52.52%, where AH Kha-010 showed the highest edible portion (52.52%) followed by AH Kha-011 (52.38%) and the lowest edible portion was observed in AH Kha-009 (32.83%).

Evaluation of existing superior jackfruit lines

Performances of six jackfruit germplasm were studied at the Agricultural Research Station, Pahartali, Chittagong. The earliest flowering was observed in AH Pah-006 (Early December) followed by AH Pah-004 (Mid December). Maximum harvesting duration was observed in AH Pah-004 (Late April-Late July). Maximum base girth (210 cm) was obtained from AH Pah-006 and minimum base girth (89 cm) was obtained from AH Pah-005. Maximum number of fruits per plant (120) was produced in AH Pah-004, whereas minimum number fruits per plant was produced by AH Pah-005 (35). The heaviest fruit was registered in AH Pah-002 (8.310 kg) and the lightest fruit was observed in AH Pah-005 (3.0 kg). Maximum number of bulbs (117) was produced by AH Pah-001 where, minimum (34) number of bulbs was produced by AH Pah-004. Individual bulb weight was noted higher (54.41g) in AH Pah-002 compared to lower (16.00) bulb weight in AH Pah-001. Edible portion was found to be the highest (54.00%) in AH Pah-004 followed by AH Pah-001 (44.77%) as against the lowest (36.10%) edible portion in AH Pah-005. The highest TSS was observed in AH Pah-006 (23.00%) followed by AH Pah-004 (21.50%). The bulbs of AH Pah-004 are excellent to taste.

Evaluation of coloured mango germplasm

One mango germplasm (MI Jes-001) was evaluated at RARS, Jessore. The age of the tree was 15 years. Plant and fruit characteristics were studied. The germplasm was very much attractive for its nice colour and the average number of fruits per plant was 412 having individual fruit weight of 220 g. The germplasm showed earliness in flowering and harvesting. The date of flowering was 16 January 2016 and the first harvest was done on 11 May 2016. So, the duration from flowering to harvest was 115 days. The colored mango was periodically harvested for 7 times and the date of last harvest was 22 May 2016.

Performance of some promising mango varieties/cultivars under Patuakhali condition

Six mango varieties viz., BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4, BARI Aam-5, BARI Aam-8; six commercial mango cultivars- Khirshapat, Langra, Mollika, Gopalbhog , Fazli and MI Pat-05 planted in 2010 were evaluated at the RHRS, Lebukhali, Patuakhali. These mango germplasm were evaluated for their vegetative as well as fruiting behavior. The highest base girth was observed in BARI Aam-3 (63.3 cm) which was followed by Fazli (63.0 cm) and the lowest base girth was observed in Mollika (36.6 cm). Early flowering was found in BARI Aam-1 and Gopalbhog (2nd week of Feb). BARI Aam-2, BARI Aam-3, Mallika, MI Pat-05, Fazli and Langra were noticed as mid-season variety/cultivar in terms of flowering. The highest number of fruit was observed in BARI Aam-3 (395) and the lowest number of fruit was noted in BARI Aam-1 (10.67). The highest fruit weight was obtained from BARI Aam-4 (527.67 g) and the lowest from BARI Aam-3 (189.0 g). Maximum yield per plant was recorded in BARI Aam-3 (74.57 kg/plant) and minimum in BARI Aam-1 (2.99 kg/plant). BARI Aam-3 produced 5% jelly seed.

Evaluation of Green mango (Kachamitha) mango germplasm at hill valley in Chittagong hill tracts

Three green mango (kachamitha) germplasm (MI Rai-005, MI Rai-007 and MI Rai-008) were evaluated at Raikhali to find out the superior one. The age of mango germplasm was four. The plant height varied from 216.6 to 430.0 cm. The tallest plant (430.o cm) was observed in MI Rai-008. The shortest plant (226.6 cm) was found in MI Rai-007. Base girth ranged from 61.5 to 31.0 cm. The highest base girth was recorded in MI Rai-008 (61.5 cm) and the lowest base girth was recorded in MI Rai-007(31 cm). The highest fruit weight (226.5 g) and edible portion (78.6%) were recorded in MI Rai-008. On the other hand, the lowest fruit weight (97.97 g) and edible portion (72.9%) were found in MI Rai-007. Maximum TSS (9%) was found in MI Rai-005 and minimum TSS (7%) was found in MIR007. The germplasm MI Rai-008 was found very promising with respect to organoleptic test.

Performance of BARI released mango varieties in Chittagong hill tracts

Performance of nine years old mango varieties viz., BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4 and BARI Aam-8 were evaluated at the hill valley of Raikhali. Maximum plant height (695.0 cm) and fruit yield (19.7 t/ha) were observed in BARI Aam-8. The plant height varied from 34.0 to 695.0 cm. The tallest plant (695.0 cm) was observed in BARI Aam-8 which was significantly higher than all other treatments. The shortest plant (341.0 cm) was found in BARI Aam-4. The base girth ranged from 43 to 77.5 cm. The highest base girth (77.5 cm) was recorded in BARI Aam-1, whereas the lowest base girth (43.0 cm) was recorded in BARI Aam-4. Maximum canopy spreading (474.0 cm in NS × 498.0 cm in EW) was noted in BARI Aam-8 and minimum (330 cm in NS × 320 cm in EW) spreading was noted in BARI Aam-4. The earliest flowering (mid January) in BARI Aam-8 and the latest flowering (first February) was observed in BARI Aam-1 and BARI Aam-2. The earliest fruit harvest (last May) was registered in BARI Aam-1 followed by BARI Aam-2 (first June), BARI Aam-3 (last June), BARI Aam-8 (first July) and BARI Aam-4 (first July). The biggest fruit (439.3 g), highest edible portion (76.1%) as well as yield (17.6 t/ha) were manifested in BARI Aam-4. Maximum TSS (21.3%) and the highest fruits per plant (303.3) were recorded in BARI Aam-3. The lowest number of fruits per plant (101.3), edible portion (66.9%) and fruit yield (5.4 t/ha) were recorded in BARI Aam-1.

Performance of green sweet mango (kanchamitha) germplasm at the hilly region mango

One green sweet mango (kanchamitha) germplasm (MI Kha-001) was evaluated at the Hill Agricultural Research Station, Khagrachari. The full blooming period was second week of January. The tree habit was spreading to intermediate type. Fruit harvesting date was 28 April 2017. Edible portion was found 70.37%. Total Soluble Solids (TSS) was noted 9.0%. Overall growth condition of the germplasm was found satisfactory. Considering the fruit characters and edible quality the mango germplasm MI Kha-001 was considered as a promising green sweet mango (kachamitha) mango germplasm.

Inter-varietal hybridization in mango

A hybridization programme was conducted at RHRS, Chapai Nawabganj. A total of 3,385 flowers from 645 panicles were emasculated and pollinated. Seven fruits from the crosses of Langra x BARI Aam-3 and six fruits from the crosses of BARI Aam-3 x BARI Aam-4 were harvested. These fruits were harvested at proper mature stage and stones of the fruits were sown in soil for germination in the hybrid seedling plot. After germination, these one-year old hybrid seedlings will be transplanted in the main field to continue evaluation in the following years.

Hybridization in green sweet mango (kanchamitha) mango

A hybridization programme was conducted at RHRS, Chapai Nawabganj. A total of 327 flowers from 146 panicles were emasculated and pollinated. Thirty two fruits from the crosses of Mallika x BARI Aam-9 were set initially but none reached at maturity. The study will be continued in the next year.

Performance of some mango hybrids

Five mango hybrids namely MI Cha Hy-057, MI Cha Hy-058, MI Cha Hy-080, MI Cha Hy-089 and MI Cha Hy-090 were evaluated at the RHRS, Chapai Nawabganj. Among the hybrids, fruit weight was noted maximum in MI Cha Hy-080 (368.05 g), while minimum fruit weight was noted in MI Cha Hy-058 (220.38 g). The highest fruit yield was recorded in MI Cha Hy-059 (81.66 kg/plant) while the lowest fruit yield was recorded in MI Cha Hy-080(1.84 kg). MI Cha Hy-058 had maximum edible portion (78.61%), whereas minimum (66.72%) edible portion was noticed in MI Cha Hy-089. The highest TSS (23.30 %) was recorded in MI Cha Hy-058 while minimum TSS (19.67%) was recorded in MI Cha Hy-090. The highest fruit fly infestation was recorded in MI Cha Hy-058 (30%) while other lines had lower infestation (20%). All the lines were resistant to anthracnose and highly resistant to floral malformation. The hybrids, MI Cha Hy-058, MI Cha Hy-059 and MI Cha Hy-089 were found resistant to stem-end rot.

Evaluation of two green sweet mango (kanchamitha) germplasm

Fruits of two green sweet mango (kachamitha) germplasm were collected before maturity and evaluated in the laboratory of RHRS, Chapai Nawabganj. Bigger fruit (205.9 g) was obtained from MI Cha-01/17 whereas lighter fruit was obtained from MI Cha-02/17 (192.5 g). Number of fruits per plant (1360) as well as yield per plant (280 kg) was found higher in MI Cha-01/17. Higher edible portion (61.8%) was obtained from MI Cha-02/17, whereas higher TSS (6.5%) was observed in MI Cha-1/17.

Performance of SOM-1049 mango germplasm

The original plant of SOM-1048 mango germplasm was selected through survey from Chapai Nawabganj district in 2002. Then the scions were collected from selected plants and grafted on rootstocks at the nursery of RHRS, Chapai Nawabganj and given name as SOM-1049. Performance of SOM-1049 mango germplasm was evaluated at RHRS, Chapai Nawabganj. Plants grafted with the scions of SOM-1048 in 2012 showed winter harvest (November 2015 to February 2016) with quality fruits. Three plants produced fruits and average number of fruits was 36. The fruits are still in the tree and unripe. Expected harvesting date of fruit is September, 2017.

Collection and evaluation of some coloured mango germplasm

For collecting superior coloured mango germplasm from Rajshahi and Chapainawabganj district, a mango show was organized in 2008. Thirty six coloured mango germplasm were identified thorugh mango show. Planting materials were produced through collection of scions, performing grafting on mango rootstock and grafts were planted in July 2009. Wide variation was observed among the germplasm regarding growth and tree characteristics. Among the germplasm, 18 produced fruits in 2016-17. Maximum fruit weight was recorded in MI Cha-20 (650.0 g) followed by MI Cha-21 (550.0 g) but minimum fruit weight was recorded in MI Cha-011(133.0 g). Significant difference in number of fruits/plant and weight of fruit/plant was observed among different mango germplasm. The highest number of fruits was recorded in MI Cha-009(55) and the lowest number of fruits was recorded in MI Cha-001 (3). The highest fruit yield was recorded in MI Cha-009 (13.47 kg/plant) and the lowest fruit yield in MI Cha-001 (0.69 kg/plant).

Physio-morphological characteristics of exotic mango germplasm

A study on Ppysio-Morphological characteristics of exotic mango germplasm was conducted at RHRS, Chapai Nawabganj. The study included eight germplasm namely kent, keitt, palmer, M-3896, M-3836, GBM-502, rad and ruby. The highest plant height was recorded in Palmar (8.3 m) and the lowest in GBM-502 (7.7 m). Base girth varied from 1.2 m to 1.4 m. Maximum base girth was recorded in GBM-502(1.4 m) and minimum in Palmar (1.2 m). Tree volume differed from 172 to 332 m^3 between the mango germplasm. Maximum tree volume was obtained from GBM-502 (332 m^3) and minimum from Palmar (172m^3). Between the two germplasm, maximum fruit fly infestation was observed in the germplasm Palmar while minimum infestation was recorded in the germplasm GBM-502. Palmar showed the highest incidence (50%) of post harvest anthracnose, while the lowest (40%) incidence was recorded in GBM-502. The highest incidence of stem end rot (25%) was recorded from Palmar in comparison to minimum (20%) incidence in GBM-502.

Evaluation of superior mango genotypes

Four genotypes of mango, namely MI Pah-001, MI Pah-002, MI Pah-003 and MI Pah-004 were evaluated at the Agricultural Research Station, Pahartali. The germplasm MI Pah-001 had the tallest plant (3.44 m) and MI Pah-002 had the shortest plant (2.10 m).The highest base girth (40.3 cm) was produced by MI Pah-001, whereas the lowest base girth was produced (31.6 cm) by MI Pah-004. The earliest flowering was observed in MI Pah-001 and the latest in MI Pah-004. Earlier harvesting was achieved in MI Pah-001 on the first week of May and the latest harvesting was achieved in MI Pah-004 on first week of June. The biggest fruit (393g) was observed in MI Pah-003 followed by MI Pah-004 (347g) and the smallest fruit (163g) was observed in MI Pah-001. The highest edible portion (84.30 %) was noted in MI Pah-003 and the lowest edible portion (65.72 %) was noted in MI Pah-001. Maximum TSS was observed in MI Pah-004 (19.6%) followed by MI Pah-002 (18.2%) and MI Pah-003 (18.6%) and minimum TSS was observed in MI Pah-001 (17.8%).

***In situ* evaluation of off-season mango germplasm**

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi to observe the performance of three off-season mango germplasm viz., MI Isd-001, MI Isd-002 and MI Isd-003. The highest number of fruits per plant was obtained from MI Isd-002 (400). Maximum individual fruit weight was recorded in MI Isd-002(248 g). Edible portion was recorded the highest in MI Isd-001 (66.33 %). The highest TSS was also observed in MI Isd-001 (17.5%).

Clonal selection of mango cv. Harivanga

The experiment was carried out at RARS, Burirhat, Rangpur to develop mango variety of Harivanga with regular bearing habit. Twenty four Harivanga germplasm were selected from 24 orchards of Mithapukur and Bodorgonj upzilla under Rangpur district. Out of 24 germplasm only 8 germplasm gave flowering in this season. In the first year, a total 24 germplasm gave flower. But in the 2nd year, out of 24 germplasm only 4 germplam (MI Hari (Bur)-001, MI Hari (Bur)-004, MI Hari (Bur)-017 and MI Hari (Bur)-019) gave flower (including above 4). From the last consecutive 4 years study, it may be concluded that the Harivanga might have shy or alternate bearing habit. The germplasm MI Hari (Bur)-001, MI Hari (Bur)-004, MI Hari (Bur)-017, MI Hari (Bur)- 019 and MI Hari (Bur)-022 were found to be regular bearer for last 4 years. The results revealed that the germplasm MI Hari (Bur)-005 was noticed superior with respect to average fruit weight (400 g), TSS (19%), pulp weight (312.3g) and edible portion (78.09%).

Evaluation of exotic mango germplasm

An exotic mango germplasm (MI Raj-001) collected from Saudi Arabia was characterized at the Fruit Research Station, BARI, Binodpur, Rajshahi. The germplasm MI Raj-001 had 4.5 m of plant height and 45 cm of base girth. Average fruit weight was 440 g. Edible portion and TSS of MI Raj-001 were 76% and 19%, respectively in comparison to BARI Aam-4 (check variety) which contained TSS and edible portion of 78% and 17%, respectively. Other fruit characteristics were more or less similar of those of the two germplasm. Number of fruits was produced by the exotic mango germplasm (MI Raj-001) was 60. Maturity period of fruit was 2nd week of July. The fruit had very attractive yellowish maroon colour at ripe stage.

Characterization and evaluation of late mango germplasm

Evaluation of late mango germplasm (MI Raj-002) was carried out at the Fruit Research Station, Rajshahi. The germplasm MI Raj-002 was collected from Rajshahi region in 2010 and grafted through top working on a seedling mango plant. The mango germplasm flowered twice in a year. First flowering occurred in the month of February, and the fruits were harvested in the month of June and second flowering occurred in the month of May, and the fruits were harvested in the month of September. The germplasm MI Raj-002 produced 186 number and 146 kg of fruits in the mid season production during 2014-15. In case of late season production, tree bore 140 number and 21 kg of fruits. The individual fruit weight of MI Raj-002 was recorded as 270 g in the main season and 152 g in the late season. TSS of main season fruit was 18, while it was 20 in the late season fruit.

Regional yield trial of table banana germplasm

One selected superior banana line (MS Jes-001) was evaluated at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur as against BARI Kola-3. The germplasm MS Jes-001 produced taller plant (3.69 m) than BARI Kola-3 (3.63 m). Base girth of MS Jes-001 and BARI Kola-3 were 80.17 and 81.16 cm, respectively. Number of leaves at shooting was recorded to be 13.15 in MS Jes-001 and 13.20 in BARI Kola-3. Required time to shooting and harvesting in MS Jes-001 were 331.6 and 417.17 days, respectively. On the other hand, time required to shooting and harvesting in BARI Kola-3 were 318.7 and 406.0 days, respectively. Maximum number of fingers per bunch (248.4) was recorded in MS Jes-001 compared to BARI Kola-3 (192.5). MS Jes-001 produced heavier bunch (21.94 kg) compared to lighter bunch in BARI Kola-3 (19.84 kg). BARI Kola-3 resulted in maximum finger weight (112.97) as compared to minimum finger weight in MS Jes-001 (87.26 g). Higher fruit yield was noted in MS Jes-001 (51.95 t/ha) compared to that of BARI Kola-3 (49.6 t/ha).

Evaluation of seeded banana germplasm at Jamalpur region

An experiment was carried out at RARS, Jamalpur. Eight local seeded banana germplasm viz. MS Jam (SB)-01, MS Jam (SB)-02, MS Jam (SB)-03, MS Jam (SB)-04, MS Jam (SB)-06, MS Jam (SB)-09, MS Jam (SB)-10 & MS Jam (SB)-13 and two exotic seeded banana germplasm viz. MS Jam (SB)-ISD-01 & MS Jam (SB)-ISD-05 were included in the study. Significant differences were observed in vegetative and reproductive characters, harvesting time, fruit yield, yield contributing characters and post-harvest quality among the local and exotic seeded banana germplasm. The germplasm MS Jam (SB)-10 produced the tallest plant (4.65 m) and MS Jam (SB)-ISD-05 produced the shortest plant (3.21 m). Maximum base girth (65.00 cm) and number of leaves (8.67) were found in MS Jam (SB)-01 and MS Jam (SB)-13, respectively. Base girth and number of leaves were found maximum in MS Jam (SB)-01 (65.00 cm) and MS Jam (SB)-13 (8.67), respectively. The germplasm MS Jam (SB)-ISD-05 took maximum days to panicle emergence (325.6), first flowering (335.7), last flowering (345.3) and days to harvest (440.3) whereas, minimum days to panicle emergence (229.4), first flowering (238.8), last flowering (248.4) & days to harvest (343.4) were required by the germplasm MS Jam (SB)-ISD-01. The germplasm MS Jam (SB)-02 exhibited the highest bunch weight (19.0 kg) and number of hands per bunch (11.0). The highest average fruit weight of individual hand (2.27 kg) was found in MS Jam (SB)-01. The length and breadth of bunch were noted to be maximum in MS Jam (SB)-02 and MS Jam (SB)-10 (60.00 cm and 40.50 cm), respectively. Number of fingers per hand was noted the highest in MS Jam (SB) -02 (14.90). MS Jam (SB)-10 exhibited the biggest finger (200.0 g) as against the smallest finger in SB-02 (123.0 g). The line MS Jam (SB)-02 resulted in maximum fruit yield (43.50 t/ha), while MS Jam (SB)-09 exhibited minimum fruit yield (25.33 t/ha).

Regional yield trial of banana lines

Six local and exotic germplasm of banana were evaluated to identify the superior one for the regional adaptability of banana at RARS, Jamalpur. Significant differences were observed in vegetative and reproductive characters; harvesting time, fruit yield, yield contributing characters and post-harvest quality of local and exotic banana. Plant height at shooting varied from 1.62 m to 3.11 m, where ITC-570 got the shortest and ITC-1441 the tallest plant. ITC-1320 produced the highest base girth (78.0 cm) as compared to the lowest base girth in Dud Sagar (45.4 cm). Maximum number of leaves was obtained from ITC-1320 (7.17) whereas ITC-570 produced minimum number of leaves (5.67). Finger length ranged from 9.35 to 13.53 cm, where Kabri attained the lowest and Dud Sagar the highest fruit length. The highest number of hands per bunch was recorded in ITC-1320 and ITC-1441 (11.00) and the least in Kabri (7.50). ITC-1441 got the highest number of fingers per hand (16.50), whereas Kabri got the lowest (12.49) number of fingers. ITC-1320 produced the highest fruit yield (41.77 t/ha) closely followed by Dud Sagar and ITC-570 (30.55, 30.17 t/ha), respectively whereas, Kabri produced the lowest yield (15.48 t/ha). Kabri exhibited the highest edible portion (82.49%) as compared to the lowest edible portion in ITC-1441 (77.78). The highest TSS (21.50%) was found in Kabri closely followed by ITC-1441(21.0%) and Dud Sagar (20.8 %) whereas; BARI Kola-1 produced the lowest TSS (18.11%). Dud Sagar exhibited the highest shelf life (7.35 days) as compared to the lowest shelf life in ITC-570, Kabri and BARI Kola -1 (4.0 days).

Clonal selection of banana cv. Amritsagor

More than five hundred Amrit sagor germplasm were collected from 10 different locations and planted at the research field of RHRS, Narsingdi to evaluate and identify the superior clones. One sucker per plant of first year crop was allowed to grow before maturity of the 1st crop. Among them plant height at shooting varied from 1.90 to 2.76 m, where MS Nar-010 was the shortest and MS Nar-009 the tallest plant. The highest number of hands per bunch was recorded in MS Nar-004 (8.43) and the lowest number of hands per bunch was noted in MS Nar-005 (6.04). MS Nar-006 got the highest number of fingers per hand (18.04) whereas, MS Nar-010 got the lowest (13.67) number of fingers. MS Nar-005 produced the highest fruit yield (37.43 t/ha) closely followed by MS Nar-002 (37.02 t/ha) and MS Nar-009 produced the lowest fruit yield (29.73 t/ha). MS Nar-002 exhibited the highest edible portion (75.9%) as compared to the lowest in MS Nar-003 (68.23%). MS Nar-008 exhibited the highest shelf life (7.78 days) as compared to the lowest shelf life in MS Nar-009 (5.68 days).TSS was recorded maximum in MS Nar-003 (21.03%) and minimum in MS Nar-009 (18.22%). Based on the results obtained from the experiment, it may be concluded that the accession MS Nar-005 and MS Nar-002 performed better in terms of yield and quality. This is first year of evaluation. Fruits of only 23 lines under 10 accessions were harvested. Final conclusion will be made after completion of total harvest.

Hybridization in litchu

Hybridization in litchi was carried out at the Fruit Research Farm of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute, Joydebpur, Gazipur to incorporate some important characters like earliness, lateness, colour, regular heavy bearing in the desired variety or cultivar. Cross combinations for hybridization were: BARI Litchu-3 x BARI Litchu-4, BARI Litchu-2 x BARI Litchu-4, BARI Litchu-3 x BARI Litchu-1, Kathali x BARI Litchu-4, and Kathali x BARI Litchu-1. Initial fruit set was found 5 in BARI Litchu-3 × BARI Litchu-4 cross combination and finally harvested 3 fruits. BARI Litchu-2 × BARI Litchu-4 cross combination produced 3 fruits but no fruits were harvested. From the cross combination Kathali × BARI Litchu-4, initial fruit set was recorded to be 13. All fruits were dropped in the marble stage and finally no fruit was harvested. From the cross combination Kathali × BARI Litchu-1, two fruits were harvested. Seeds of all fruits were sown in pot but not yet germinated.

Evaluation of litchi germplasm

Ten litchi germplasm viz., Bombai, Kadmi, Mozaffarpuri, China-3, Madrazi, Bedana, China-2, Kathali, BARI Litchu-3 and BARI Litchu-4 were evaluated at the Regional Agricultural Research Station, Ishurdi, Pabna. The experiment was initiated in 2012. Large sized fruit (4.32 x 4.08 cm) was obtained from Bombai whereas, maximum fruit weight was obtained from BARI Litchu-4 (29 g). Minimum fruit weight was recorded in Muzaffarpuri (21.20 g). The highest edible portion was recorded in China-3(75.7%). TSS was recorded to be 15.9 to 17.0% among the harvested fruits of litchi germplasm.

Purification of shahi papaya

An experiment was carried out at the Fruit Research Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur to purify the Shahi papaya variety during 2016-17. Sib-mated seeds of purified Shahi papaya were collected from identified deep red fruits, which were elliptic in shape (Shahi shaped). The seeds were sown on the first week of December 2016 in polythene bag. Two months old seedlings were transplanted in the field on 01 March 2017. Seedlings of purified sib-mated seeds were transplanted in the main field on March 2017 and the Sib-mating process (selfing of five flowers from each plant) for this year was started on June 2017 and it would be continued. In June 2017, a total of 695 flowers were sib-mated, among those 652 fruits have been set. Date of first flowering was noted on 24 April 2017. Plant height and base girth at first flowering were recorded 74.2 cm and 10.4 cm, respectively. The position of first flower in the plant was 58.7 cm above from the ground. Plant took 65 days for first flower opening from transplanting. After harvesting data on various fruit characters will be collected and compared with the standard Shahi papaya. The results of the previous years' study (from 2007-08 to 2015-16) were very near to the characteristics of the original Shahi papaya. It is expected that the experiment result of 2016-17 would be very close to the original Shahi papaya and the pure Shahi papaya characters would be fully regained.

Development of population for gynodioecious papaya variety

Development of gynodioecious population for obtaining 100% productive plants with a view to increase farm income through papaya cultivation was performed at the Fruit Research Farm of Pomology Division under HRC, BARI, Gazipur. Three sets of plants namely S_3 progeny of CP Joy-005, CP Joy-009 and BC_1 progeny were included in the study. Among the three sets, S_3 progeny of CP Joy-005 produced 50, 30 and 20 percent andromonoecious, female and male plants, respectively; S_3 progeny of CP Joy-009 produced 40, 46.7 and 13.3 percent andromonoecious, female and male plants and the BC_1 progeny produced 25, 33.3 and 41.7 percent andromonoecious, female and male plants, respectively. Considering the number of fruits per plants, 34, 28 and 30 fruits were recorded in CP Joy-005, CP Joy-009 and BC_1 respectively. Fruits of S_3 progenies showed light to bright yellow flesh colour but in BC_1 it was light red to red colour. TSS (%) of fruits were 10.50, 9.00 & 8.50 in CP Joy-005, CP Joy-009 and BC_1, respectively. The average fruit weight of S_3 progeny of CP Joy-005 and CP Joy-009 was 1346 g and 883 g, respectively and 1108 g in BC_1 progeny. Fruits of S_3 progenies were noticed elongate & oblong in shape and greenish yellow in skin colour at ripe stage with light to bright yellow flesh. On the other hand, fruits of BC_1 progeny were noticed elongate & elliptic in shape with light red to red colour flesh. No bitterness was found in the selected fruits and TSS (%) was noted 10.50 and 9.00 in S_3 progeny of CP Joy-005 and CP Joy-009, respectively and 8.50 in BC_1 progeny. To draw a final conclusion and to develop a variety containing 100% productive papaya plant, time for research should be extended by at least 3-4 years.

Purification of shahi pepe

An experiment was carried out at the Fruit Research Station, BARI, Binodpur, Rajshahi to purify the Shahi pepe variety. Seedlings of purified selfed seeds were transplanted in the main field on March 2016 and 10 flowers of each plant were selfed (Sib mating) from June to August, 2016. A total of 650 flowers were selfed among them, 608 numbers of fruits have been set.

Collection and evaluation of local ber (sour) germplasm

An evaluation of forty four ber germplasm was performed which were collected from the village Nimuria, Amuna, Sukundi, Marta, Balda, Bigda, Kanaia and Biruda of Gazipur district. Besides this, two germplasm were collected from Jamalpur and one germplasm was collected from ARS, Pahartali, Chittagong during November 2016 to March 2017 to select the superior sour ber germplasm. Twenty fruits of each tree were plucked randomly, of which ten was used for studying their physical and qualitative characteristics. Among the studied ber germplasm the line ZM Pah-044 produced the largest fruit (17.80 g) and the line ZM Joy-013 produced the smallest fruit (2.30 g). The stone weight ranged from 0.40-1.44 g. Considering fruit characteristics and yield potentialities ZM Pah-044, ZM Joy- 009, and ZM Joy- 006 were found promising and may be recommended for further evaluation.

Collection and evaluation of ber germplasm

An experiment to identify suitable ber germplasm was conducted at HRC fruit orchard, RARS, Jamalpur. Fifty eight accessions were included in the study. Wide range of variation was noted regarding quantitative and qualitative fruit characters. Plant height ranged from 2.50 to 5.90 m. Base girth ranged from 28.00 to 73.00 cm. Flowering time of all ber germplasm was on August to September-2016. Harvesting time ranged from 1st week of February to last week of March-2017. Individual fruit weight ranged from 4.12 to 42.09 g, where ZM Jam-009 (Dhaka-90) had the maximum and ZM Jam-188 had the minimum fruit weight. Yield per plant varied from 13.00 to 65.00 kg, where ZM Jam-253 got the minimum and ZM Jam-103 (BARI Kul-2) had the maximum. Edible portion varied from 49.70 % to 98.14 %, where the line ZM Jam-103 had the least and ZM Jam- 157 got the highest value. TSS varied from 9.00 to 22 %, where ZM Jam-188 got the maximum and ZM Jam-262 exhibited the minimum TSS. Wide range of variability regarding qualitative characters was observed among fifty eight ber germplasm. Oval, oblong and round shaped fruits were observed among the germplasm. Fruit skin colour ranged from light yellow, yellowish, yellowish green, greenish yellow and yellowish with reddish shade. Regarding crispiness variation was noted among the germplasm which were crispy and medium crispy. Sweetness of fruit ranged from sweet to soury sweet and sour. Taste the most important trait varied from good to very good. Biochemical analysis of seven selected superior germplasm was done. p^H ranged from 3.17 to 3.74; Vit-C varied from 10.58 to 61.15 mg/100g where ZM Jam-223 got maximum and ZM Jam-208 exhibited minimum. Total acid ranged from 0.89 to 2.11%. The highest reducing sugar was found from ZM Jam-122 (8.06%) and the lowest from ZM Jam-208 (5.40%). Total sugar ranged from 5.75 to 8.47%. β-carotene ranged from 11.23 to 26.18 µg/g, where ZM Jam-122 got maximum and ZM Jam-240 exhibited minimum content. Considering individual fruit weight, yield per plant, % edible portion, % TSS, crispiness, soury sweet taste, Vit-C content, moisture content and Vit-A content, some lines viz. ZM Jam-122, ZM Jam-223 and ZM Jam-244 were selected as superior ones and may be released as ber variety.

Evaluation of ber germplasm

The present study was conducted at CRS, Jaintiapur, Sylhet to evaluate the local ber germplasm. Three ber germplasm of twenty years old were included in the study. There were differences among the germplasm studied regarding plant height, base girth, spreading, number of branches/plant, number of fruits per plant and yield. The highest plant height (4.2 m) and the largest canopy were recorded in ZM Jai-003. Maximum number of fruits/plant (4624) and yield (32.41 t/ha) were found in ZM Jai-003. There were variations among the quantitative fruit characters also. The largest fruit (3.75×3.11 cm) with maximum fruit weight (25.23 g) was recorded in ZM Jai-003. Maximum TSS% was found in ZM Jai-001 (10.2%), while maximum edible portion was recorded in ZM Jai-003 (93.74%).

Evaluation of indegenous ber germplasm at Khagrachari

Thirty two local ber germplasm was evaluated at the Hill Agricultural Research Station in Khagrachari. The plants were about twelve years old. Average fruit weight ranged from 4.5 to 16.8 g. The germplasm ZM Kha-032 produced the highest fruit weight (16.8 g) followed by ZM Kha-031(13.9 g). The lowest fruit weight was recorded in ZM Kha-002 (4.5g). Edible portion ranged from 52.6% in ZM Kha-026 to 93.41% in ZM Kha 031. TSS varied from 10.40% to 24.2%. In case of fruit color at mature stage it varied from greenish yellow to yellow in maximum germplasm. Harvesting period varied from February to March but most of the fruits were harvested in February. Shape of fruit was oval to round and taste of all fruits was almost soury sweet. Among the 32 local ber germplasm 7 were found promising, which will be selected for further study.

Collection and evaluation of existing ber germplasm

An experiment was conducted at the Regional Horticulture Research Station, Chapai Nawabganj to find out the superior cultivars of ber for cultivation in that region as well as to find out late the variety. In this experiment ten ber germplasm (Apel kul, BARI Kul-1, BARI Kul-2, BAU Kul-1, Comilla Kul, Sabji Kul, Thai kul and ZM Cha-010) were used. Among the cultivars Thai Kul produced the largest fruit (89.8 g) and Appel Kul produced the smallest fruit (26.4 g). The highest TSS was recorded in BARI Kul-1(21%) and the lowest in Sabji kul(16%). The highest (98%) and the lowest (94%) edible portion were recorded in Thai kul and Chapai kul, respectively. The highest yield was obtained in Thai Kul (47.7 t/ha) and the lowest (23.3 t/ha) in Appel kul. Chapai kul (ZM Cha-010) harvested on 15th

April which was too late among the studied germplasm. The germplasm ZM Cha-010 was found promising as a late one. Two major diseases namely powdery mildew and sooty mould were observed in this study. Among the cultivars Apel kul, BARI Kul-1, BARI Kul-2, BAU Kul-1, Thaikul, ZMCha 010 and Dhaka 90 were moderately resistant to powdery mildew disease and rest of the cultivars were moderately susceptible. But in case of sooty mould infection BARI kul-1, BAU kul-1, Thai kul and Dhaka 90 were found resistant at Chapai Nawabganj condition. Four insects namely mealy bug, Busket worm, Leaf hairy cater pillar and fruit borer infestation were also observed. Apel kul and Dhaka were susceptible to busket worm infestation. Leaf hairy caterpillar and fruit borer were not serious problem for most of the cultivars.

Evaluation of indigenous ber germplasm at Pahartali

The experiment was conducted at the Agricultural Research Station, Pahartali, Chittagong with two ber germplasm (ZM Pah-001 and ZM Pah -002). Both of them produced flowers in August-September and the fruits were harvested during February to March. Fruit weight of ZM Pah-001 and ZM Pah -002 were recorded to be 16.01 and 12.12 g, respectively. The highest edible portion was recorded to be 81.2 % in ZM Pah-001 and 66% in ZM Pah-002. Number of fruits per plant was 3215 recorded in ZM Pah-001 and 2845 in ZM Pah -002. Fruit yield of 6 years old plant in ZM Pah-001 was 46.23 kg/plant followed by control 39.31 kg. Fruit yield was 14.95% higher over the local line ZM Pah -002. Total soluble solids (TSS) were 18 % in ZM Pah-001. In respect of fruit shape, skin color, flesh color, crispiness, taste and shelf life, ZM Pah-001 was noted superior over control. No disease was found during the study period. Fruit fly infestation was very minimum in ZM Pah-001(5%) as against the germplasm ZM Pah -002 (12 %). After several years of evaluation, the line ZM Pah-001 was found promising in terms of adaptability, yield, edible portion, organoleptic taste and other quality and tolerance to pest and diseases. So, the germplasm ZM Pah-001 has been released as a sour ber variety.

Collection and evaluation of ber germplasm

Ten ber germplasm viz., Apel kul, BARI Kul-1, BARI Kul-2, BARI Kul-3, Chapai Kul, Dhaka- 90, Sabji Kul, Local kul late and Umboli kul were evaluated at Fruit Research Station, Binodpur, Rajshahi. Bari Kul-3 produced the maximum fruit weight (44.2 g) and it was recorded minimum in Umboli Kul (12.5 g). The highest total soluble solid was recorded in Umboli kul (17.0%) followed by BARI Kul-1 (16%) and Sabji Kul(16.0%).The lowest TSS was observed in Chapai Kul (10.00%) and Dhaka-90 (10.0%). BARI Kul-3 produced the highest fruit yield (25.27 t/ha) and Umboly Kul the lowest (10.25 t/ha). Apple Kul contained the highest moisture (87.80%) followed by BARI Kul-1 (84.70%). Local Kul contained the lowest moisture (78.36%). Three major diseases namely powdery mildew, sooty mould and fruit rot were recorded in this study. A large number of ber germplasm were moderately resistant to powdery mildew and susceptible to sooty mould. Most of ber germplasm were moderately resistant to fruit rot. Two insects namely mealy bug and fruit borer were also taken under consideration. Mealy bug infestation may occur during new shoot initiation. Most of the ber germplasm were moderately susceptible to mealy bug. BARI Kul-1, China Kul and Local Kul Late were moderately susceptible to fruit borer. Among the other lines, Local Kul (Late) was found to be very promising for late season.

Collection and evaluation of local sour ber germplasm

A study was conducted at Rajshahi, Chapainawabganj, Pabna and Naogaon with 9 ber germplasm to select the superior sour one for processing purpose in Northern Region of Bangladesh. Twenty fruits of each tree were collected randomly, of which ten were used for studying their physical and qualitative characteristics. The ber line ZM Raj-004 had the highest fruit length (3.12 cm) followed by ZM Raj-005 (3.00 cm). On the other hand, the line ZM Raj-003 had the lowest fruit length (2.08 cm). Fruit breadth of different ber lines ranged from 1.99 cm in ZM Raj-009 to 2.85 cm in ZM Raj-004. The line ZM Raj-001 produced the largest fruit (15.6 g) and the line ZM Raj-009 produced the smallest fruit (5.5 g). The stone weight ranged from 0.8-1.2 g. Considering fruit characteristic and yield potentialities ZM Raj-001, ZM Raj-002, and ZM Raj-004 were found superior and may be recommended for cultivation in the Northern Region of Bangladesh.

Evaluation of lime germplasm

Seven lime germplasm were collected from different parts of Bangladesh and planted in the Fruit Research Farm, HRC, BARI, Gazipur on August 2013 under Citrus Development Project (BARI Part). Among them four germplasm were evaluated on the basis of both quantitative and qualitative characters. All the four studied germplasm produced ellipsoid type of fruits with green flesh colour. The highest plant height (250.00 cm) was observed in the germplasm CA Joy-002 followed by CA Joy-005 (220.00 cm). Maximum number of segments (11.33) and thinnest rind (0.40 cm) were recorded in the germplasm CA Joy-005. Similarly, juice content was also noticed maximum (26.50%) in the germplasm CA Joy-005. The highest (85.00 mg /100 g) and the lowest (63.67 mg/100 g) amount of vitamin-C were recorded in the germplasm CA Joy-002 and CA Joy-005, respectively. The amount of total acid was found the highest (8.44%) in the germplasm CA Joy-004 followed by CA Joy-005 (8.15%) and the TSS percentage was resulted the highest in CA Joy-005 (7.00%). Finally, the biggest individual fruit (81.77 g) and maximum number of fruits (572.67) as well as yield per plant (46.84 kg) were also recorded from the germplasm CA Joy-005.

Collection and evaluation of lime at Rahmatpur

Six germplasm of Kagzi lime were collected from different areas of the southern part of the country and planted in July, 2013. Wide variations in growth characteristics among the germplasm were found. Among the germplasm, the highest plant height was attained in CA Rah-01 (4.9 m) and the lowest in CA Rah-06 (2.3 m). The highest base girth was found in CA Rah-001 (30 cm) and the lowest base girth was found in CA Rah-04 (12 cm). The highest total number of fruits was recorded in CA Rah-01 (590) and the lowest one was recorded in CA Rah-04 (80). In case of average fruit weight, the biggest fruit was harvested from CA Rah-02 (41.6 g) and the lightest fruit weight was obtained from CA Rah-01 (28.2).The highest yield was manifested in the germplasm CA Rah-01 (16.64 kg/plant) as against the lowest in CA Rah-03 (2.84 kg/plant).

Collection and evaluation of lime germplasm at Narsingdi

The experiment was conducted to evaluate lime germplasm at the research field of RHRS, Shibpur, Narsingdi. Four lime germplasm were collected from different locations of Narsingdi district. Significant variation was observed in case of growth characteristics of all the germplasm. The highest plant height (2.45 m), base girth (0.13 m) and canopy spreading (1.78×1.67 m^2) were noted form the germplasm CA Nar-001. On the other hand the lowest plant height (1.18 m), base girth (0.10 m) and canopy spreading (1.32×1.37 m^2) was noted in CA Nar-005. Branching density was dense in CA Nar-001 and CA Nar-005 germplasm but sparse in CA Nar-004 and good in CA Nar-006. Growth condition was good of all the germplasm. Most of the germplasm showed variations in respect of number of fruits per plant and fruit size. The highest number of fruits/plant (225.23) was obtained from CA Nar-001 compared to the lowest (95.17) in CA Nar-006. Fruit size was observed maximum in CA Nar-001 (6.42×4.72 cm^2). Individual fruit weight ranged from 55.63 to 38.12 g. Pulp weight differed significantly among the treatments. The highest pulp weight exhibited from CA Nar-001(43.2 g) and the lowest from CA Nar-006 (33.1 g).

***In- situ* evaluation of lemon germplasm at char land**

The study was conducted at the charland of Jamalpur and Sherpur. Two lines of lemon such as CL Jam-001 and CL Jam-002 were evaluated at the farmer's field in char land of Sherpur and Jamalpur. Base girth of two germplasm was recorded 42 cm in CL Jam -001 and 35 cm CL Jam -002. Maximum number of fruits/year (1175) was obtained from CL Jam-001. Higher single fruit weight (94 g) was obtained from CL Jam -002. The line CL Jam -001 was year round and less seeded (7). Average number of seeds was found in the line CL Jam-002 (55) and it was scented.

Collection and evaluation of lemon germplasm at Comilla

The experiment was conducted at the Agricultural Research Station, Comilla. The air layered16 local lemon germplasm were collected from Barura upazilla under Comilla district during August 2015. Lemon germplasm were planted in the experimental plot in June, 2016. The average plant height was 1.94 m. Maximum plant height was recorded in CLCom-013 (2.55 m) and minimum in CLCom-005 (1.30 m). Average number of fruit was 10.5 and maximum number of fruit was found in CL Com-015 (41). Average fruit weight was observed 127.9 g. Maximum weight of fruit was obtained from CL Com-015 (159.7 g) and minimum from CL Com-012 (78.6 g).

Evaluation of Citron (Jara) germplasm at Jamalpur

The experiment was conducted at HRC, RARS, Jamalpur. Planting was done in August, 2015. Wide variation was observed among the Jara lemon germplasm in case of different growth characteristics. Germplasm CM Jam-007 was found to be superior in respect of plant height (3.42 m), base girth (19.5 cm) and canopy size (3.67 x 3.62 m) and number of branches (7.75). The lowest plant height, narrow spreading, number of branches were found in CM Jam-008. The weight of the fruit varied from 337 to 646 g. The highest fruit weight was noticed in the line CM Jam-007 and the lowest in CM Jam-006. Thickness of the rind (main edible portion) was higher in CM Jam-001(19 mm) and CM Jam-007 with 79% of the total fruit weight. Flesh weight was not an important character for jara lemon. The flesh weight was also measured which varied from 68 g to 226 g with 11 to13 numbers of segments.

Evaluation of Citron (Jara) lemon germplasm at Jaintapur

The experiment was conducted at CRS, Jaintapur, Sylhet. Four jara lemon germplasm viz. CM Jai-059, CM Jai-060, CM Jai-061 and CM Jai-062 were included in the study. Plant height varied from 61.6 to 185.6 cm. The highest plant height was observed in CM Jai-059 and the lowest in CM Jai-062. Maximum base girth was obtained from CM Jai-059 (21.33 cm) and minimum from CM Jai-062 (6.67 cm). Maximum canopy spreading (102.67×134.0 cm) was recorded in CM Jai-059. The highest number of fruits per plant (23), the heaviest fruit (830.46 g), the highest fruit yield (21.22 t/ha) were recorded in CM Jai-062 while the lowest number of fruits per plant was recorded in CM Jai-060(16). The smallest fruits (425.6g) and the lowest yield (8.94 kg/plant and 9.93 t/ha) were recorded in CM Jai-059. Taste of fruits is medium sweet to very sweet.

Collection and evaluation of Citron (Jara Lebu) germplasm at Akbarpur

Five citron lines (Jara lebu) such as CM Akb-001, CM Akb-002, CM Akb-003, CM Akb-004 and CM Akb-005 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. Five citron (Jara lebu) lines were collected through the Citrus Fruit Show in 2003. Maximum fruit weight was obtained from CM Akb-001 (845.0 g) followed by CM Akb-003 (800.0 g). Fruit length ranged from 8.40 cm in CM Akb-005 to 17.60 cm in CM Akb-001 and fruit breadth was 6.20 cm in CM Akb-005 to 10.60 cm in CM Akb-001. The highest rind thickness was also obtained from CM Akb-001 (2.80 cm) and the lowest rind thickness was 0.80 cm in CM- Akb-005. Number of fruits per plant was noted the highest in CM Akb-005 (47.0) and the lowest in CM Akb-002 (12.0). The highest fruit yield was recorded in CM Akb-001 (7.12 t/ha) followed by CM Akb-003 (7.0 t/ha). The lowest number of seed per fruit was found in CM Akb-001(44.0) and the highest in CM Akb-004(73.0). Pulp diameter was the highest in CM Akb-003 (5.50 cm) and the lowest in CM- Akb-002(4.0 cm).

Evaluation of colombo lemon germplasm

The experiment was conducted at HRC, RARS, Jamalpur to evaluate Colombo lemon germplasm. Three germplasm of Colombo lemon were included in the study. Planting was done in August, 2015. Variation was observed in case of different growth parameters among the colombo lemon germplasm tested. CL Jam-002 was noticed to produce the highest plant height (2.85m), large canopy size (3.02 x 3.67m), number of branches (9.5), number of fruits per plant (63), the highest yield (12.32 t/ha), whereas the line CL Jam-003 exhibited the lowest performance.

Collection and evaluation of colombo lemon germplasm at Narsingdi region

The experiment was conducted at the research field of Regional Horticulture Research Station, Shibpur, Narsingdi with five Colombo lemon germplasm. The plants were planted in March, 2014 in a single row system. Significant variation was observed in case of growth, yield contributing characters, yield and fruit quality of the germplasm studied. Most of the germplasm varied significantly in respect of number of fruits per plant and fruit size. The highest plant height (4.15 m), base girth (0.16 m), canopy spreading (3.65× 3.37 m^2) were noted from the germplasm CL Nar-005. Base girth (0.16 m) was noted the highest in CL Nar-005. The germplasm CL Nar-005 had maximum canopy spreading (3.65× 3.37 m^2). The highest number of fruits/plant (91.23) was obtained from CL Nar-005 compared to the lowest number of fruits/plant (83.12) in CL Nar-003. Fruit size was observed maximum in CL Nar-005 (14.16 × 7.82 cm) followed by CL Nar-004 (13.67× 6.87 cm). Maximum number of fruits/plant (91.23) and yield (16.43 t/ha) were obtained from CL Nar-005. On the other hand, minimum (83.12) number of fruits/plant and yield (11.13 t/ha) was recorded in CL Nar-003. Among the germplasm CL Nar-005 was found to free from diseases, whereas the other lines suffered from gummosis. Leaf miner was common in all the germplasm. Fruit size was noted the highest in CL Nar-005 (14.16 × 7.82 cm^2) followed by CL Nar-004 (13.67× 6.87 cm^2). Irrespective of germplasm pulp color was found white. But juicy content is high and strong juice and fruit aroma was found in CL Nar-005. The highest edible portion (63.29 %) and TSS (7.18 %) was noticed from CL Nar-005. This is second year evaluation, further study is needed to evaluate more precisely.

Evaluation of pummelo germplasm in the hilly region of Rangamati

An experiment with twelve germplasm of pummelo was conducted at the existing nine years old pummelo orchard, at the hill valley of Hill Agricultural Research Station of Raikhali for the evaluation of superior pummelo germplasm. Maximum number of fruits per plant was observed in CG Rai-005 (130) followed by CG Rai-010 (96), whereas minimum number of fruits per plant was (59) observed in CG Rai-023. The earliest flowering (mid February) was recorded in CG Rai-002 and the latest (mid March) in CG Rai-026. Quality fruit was observed in CG Rai-006, CG Rai-010, CG Rai-023 and CG Rai-028 by organoleptic test. The plant height varied from 310 to 430 cm. The tallest plant (430 cm) was observed in CG Rai-008 and the shortest (310 cm) in CG Rai-005. The plant base girth ranged between 46 to 54 cm. The highest plant base girth (54 cm) was found in CG Rai-004 and CG Rai-028 and the lowest (46 cm) in CG Rai-014. Time of first flowering varied between mid February to mid March. The earliest flowering (Mid February) was noted in CG Rai-002 and the latest (mid March) in CG Rai-026. The number of fruits per plant ranged from 59 to 130. The highest number of fruits per plant (130) was observed in CG Rai-005 followed by CG Rai-010 (96), whereas the lowest in CG Rai-023(59). The highest individual fruit weight (1200 g) was achieved in CG Rai-014 and the lowest (700 g) individual fruit weight was achieved in CG Rai-002. The depth of rind was maximum (2.3 cm) in CG Rai-006 and minimum (1.1 cm) in CG Rai-002. The number of seed per fruit was found maximum (120) in CG Rai-008 and minimum (17) in CG Rai-002. The highest fruit segment (19) was present in CG Rai-028 where as the lowest (11) was present in CG Rai-005 and CG Rai-007. Maximum edible portion (80.74%) was seen in CG Rai-028 and the lowest (61.8%) was in CG Rai-008. The highest TSS (13.2%) was found in CG Rai-014 and the lowest (7.4%) was in CG Rai-007. The bitterness is totally absent in all the germplasm except CG Rai-002. The germplasm CG Rai-006, CG Rai-010, CG Rai-023 and CG Rai-028 were very good in organoleptic test.

***In-situ* evaluation of year round pummelo germplasm**

One pummelo germplasm (CG Kha-001) with two times bearing habit was evaluated at the Hill Agricultural Research Station, BARI, Khagrachari comparing with a normal season germplasm. The germplasm CG Kha-001 flowered two times: first in March, 2016 of which fruits were harvested in October, 2016 and second in October, 2016 of which fruits were harvested in March, 2017. Number of fruits was 85 in October harvesting and 69 in March harvesting. Fruits of the normal season pummelo germplasm were harvested once in October, 2016 and the number of fruits was 48. Weight of fruit harvested in October, 2016 and March, 2017 were 1.57 and 1.45 kg, respectively. Weight of fruit of normal bearing germplasm was 1.18 kg. The edible portion of fruits of CG Kha-001 harvested at October and March were 39.1 % and 36.9%, respectively and TSS was 9.0% and 8.5%, respectively.

Collection and evaluation of citrus fruit germplasm from hilly areas

A total of 50 citrus germplasms, selected through preliminary evaluation from two Citrus Fruit Shows held in Rangamati and Bandarban Hill District were collected from these two districts and other places even from abroad during 2013-16. Among collected germplasms, 19 germplasms were pummelo, 15 were mandarin, 03 were sweet orange, 08 were lemon and 04 were lime. Minimum three (03) of each collected genotypes were transplanted to main field during 2014, 2015 and 2016. All the germplasm except few are in vegetative stage. Growth condition of all the germplasm is good.

Collection and evaluation of citrus germplasm

A total of 11 citrus germplasm were selected through preliminary evaluation from a Nursery during 2014-15. Among collected germplasms, 02 germplasms were pummelo, 01 was mandarin, 01 was sweet orange, 02 were lime and 05 were lemon. Minimum six (06) of each collected germplasm were transplanted to main field during 2014 and 2016. Among them all the germplasm were in vegetative stage except lemon germplasm. Some lemon germplasm gave fruit this year. This experiment is on-going and after completion of the experiment suitable citrus varieties will be developed.

Evaluation of sweet orange germplasm in the hill region

Two germplasm of sweet orange including BARI Malta-1 were evaluated at the Hill Agricultural Research Station, Ramgarh. Higher plant height (4.01 m) was recorded from CS Ram-001and maximum base girth (38cm) was found from the same germplasm. The germplasm CS Ram-001 had higher canopy with E-W spread and N-S spread. Maximum number of fruits (135.7) and weight of fruits (24.52 kg) were obtained from the germplasm CS Ram-001 and TSS was higher (7.10%) in BARI Malta-1followed by CS Ram-001 (7.08%). The result indicated that the germplasm CS Ram-001was promising.

Evaluation of mandarin germplasm in controlled condition under net house

The experiment was conducted at Citrus Research Station, Bangladesh Agricultural Research Institute, Jaintiapur, Sylhet with seven mandarin germplasm along with BARI Kamala-1 as check to find out suitable germplasm with higher yield and quality. A wide variation was observed in respect of yield and yield contributing characteristics of mandarin germplasm tested. The highest number of fruits per plant (34) and yield per plant (4.86 kg) were found in CR Jai-017. The largest fruit was found in CR Jai-015 (191.45 g) with maximum fruit size (6.89×7.31 cm). No seeds were found in CR Jai-014. Edible portion was noted the highest in CR Jai-017 (79.39%) but per cent total soluble solids (TSS) were recorded the highest in CR Jai-016 (13.8%). On the other hand Titratible acidity (TA) was manifested the lowest in CR Jai-017 (0.74%). The germplasm CR Jai-017 and CR Jai-018 were of deep orange colored. Fruit surface was smooth for BARI Kamala-1 and CR Jai-015, whereas other germplasm bore fruits with pitted skin. Strong adherence of albedo to pulp was found in CR Jai-014, whereas others were medium to weak. Segment shape uniformity was not found in CR Jai-014 and CR Jai-017 but the other germplasm showed uniform shaped segments. Thickness of segment wall and fruit color was found medium to thick, hollow to semi hollow and light orange to dark orange, respectively. Pulp firmness and juice content were found soft to intermediate and medium to high in all the germplasm tested. From the above study, the germplasm CR Jai-017 has already been released as BARI Kamala-3. Moreover, CR Jai-015 may be further selected to propose as a variety in terms of fruit weight, edible portion and TSS (%).

Evaluation of mandarin germplasm in the hilly region

The experiment was conducted to study the performance of mandarin germplasm collected from different locations and planted at HARS, Khagrachari. Three sets of germplasm were evaluated to identify promising mandaring germplasm in respect of fruit bearing, fruit quality and yield potentiality. There were 14, 6 and 5 germplasms in the 1st, 2nd and 3rd sets respectively. The sources of the collected germplasms were Sajek area of Rangamati district, Sylhet and Ruma of Bandarban districts. All the germplasm produced profuse number fruits per plants except CR Kha 1-02, CR Kha 1-090 and CR Kha1-038. Individual fruit weight was also varied from 52.89-158 g. The biggest fruit were recorded in CR Kha 1-044 (158.5g). The germplasm CR Kha 1-002, 003, 004, 018, 030, and 092 were inferior with respect to individual fruit weight. The TSS% of the germplasm ranges from 7.5 to 9.0. In set-2 individual fruit weight varied from 19 (CR Kha 2-007) to 45 (CR Kha 2-005) Individual fruit was also varies from 67 (CR Kha-2-006) to 145.5(CR Kha 2-005). The TSS% of the germplasm ranged from 7.35 (CR Kha 2-007) to 8.5 (CR Kha 2-005. In set-3, individual fruit weight varied from 23 (CR Kha-3-057) to 102 (CR Kha 3-069) Individual fruit also varied from 86.8 (CR Kha-3-057) to 110.5 g (CR Kha 3-068). Largest fruit was obtained from CR Kha 3-047 (6.8x6.15) and the smallest fruit was in CR Kha 3-069 (5.3 x 5.65 cm) The TSS% of the germplasm ranged from 7.5 (CR kha 3-069) to 8.5 (CR kha 3-068). Considering the fruit bearing, fruit weight and TSS% content, the germplasm CR-Kha-1-044, 042, 029 and 001 were noticed promising (Set 1). CR-Kha-2-068 has been considered as the promising mandarin germplasm (set-2). CR-Kha-3-005 was also considered as the promising mandarin germplasm (set-3).

Collection and evaluation of wood apple germplasm

The growth parameters of seven wood apple germplasm were evaluated at the Fruit Research Farm of HRC, BARI, Gazipur which were planted in June 2009. No variation was observed in plant height, base girth, and canopy spread in E-W and N-S direction. Maximum plant height (4.33 m) and base girth (66.67 cm) were observed in FL Joy-006. Most of the fruit characters did not show any significant variation except fruit weight and TSS (%) which exhibited significant variation. The biggest fruit was recorded in FL Joy-005 (403.87 g) followed by FL Joy-004 (381.83 g). The smallest fruit was obtained from FL Joy-001 (267.67 g). TSS ranged from 12.80 % to 16.17 % where FL Joy-006 had maximum (16.17 %) and minimum (12.80 %) TSS content was noted in FL Joy-001. Fruit colour of most of the genotypes was grayish white and fruit shape of all the germplasm was round. Pulp colour of the germplasm was light brown to dark brown and intermediate to excellent in taste. The fruits of all the germplasm were harvested from 2nd week of October/2016 to 1st week of January/2017. Number of fruits per plant ranged from 142.00 to 17.33 at mature stage. The highest number of fruit per plant was obtained from FL Joy-004 (142.00) as against the lowest number of fruits in FL Joy-002 (17.33).Fruits weight per plant (54.37 kg) and yield (34.09 tons per hectare) was recorded highest in FL Joy-004 compared to the lowest yield per hectare in FL Joy-002 (3.98 ton). There was no insect infestation and disease infection among the germplasm in 2016. Only some cracked fruits were found in FL Joy-007. Individual fruits of every germplasm were covered by polyethylene bag at marble stage. This bagging played a vital role for controlling insects, pests and diseases and increasing attractiveness of fruits.

Collection and evaluation of wood apple germplasm

A study was carried out at the Horticulture Research Center, Regional Agricultural Research Station, Jessore to collect and evaluate the wood apple germplasm available in Jessore region. 15 germplasm were collected from different parts of the region. Among the 15 germplasm, we have detailed data only of seven germplasm. However, as it’s a first year of collection, only we have collected the scions and grafted onto the rootstocks, which are ready for planting. Therefore, the initial data we had taken during the collection from the farmers have been provided. Among the selected germplasm, the highest number of fruits/plant (2000-2500) was observed from FL Jes-001 and FL Jess-006 and minimum from FL Jes-004 (100-200), which might be due to age difference. The individual fruit weight (357 g) was noted maximum in FL Jess-010 followed by FL Jess-004 (330 g) and minimum in FL Jess-002 (206 g). The percentage of edible portion was recorded the highest (76.60 %) in FL Jess-001 and the lowest in FL Jess-001 (65.45 %). The largest fruit was recorded in FL Jes-010 (8.20 x 8.45 cm) and the smallest fruit was recorded in Fl Jess-006 (7.75x7.15 cm).

Evaluation of wood apple (*feronia limonia*) in the hilly area of Rangamati

An experiment was conducted to evaluate the performance of wood apple in hill valley with four genotypes at Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District. Wide variation was observed in growth, yield and qualitative characters. The highest plant height, base girth and canopy spreading were manifested in FL Rai-003 which was 5.25 m, 66 cm and 6.45×5.83 m, respectively. Maximum number of fruits (135), yield per plant (60.8 kg) and edible portion (57.9 %) were found in FL Rai-003 germplasm and it was very good in taste but FL Rai-004 produced the largest fruit (469 g). Considering yield, organoleptic taste and off season characteristics, FL Rai-003 may be considered as suitable germplasm for cultivation in the hilly areas

***In-situ* evaluation of palmyra palm germplasm**

In-situ evaluation of six palmyra palm (*Borassus flabellifer* L.) germplasm was performed at two major palmyra palm growing districts viz. Mymensingh and Madaripur of Bangladesh. During normal bearing period, fruit harvesting date ranged from 15 September to 12 October 2016. The highest plant height (12 m) was recorded in the germplasm BF Joy-014. Maximum base girth (203 cm) was noticed in the germplasm BF Joy-011. Number of bunch per tree (10) and the number of fruits per bunch (9) were recorded the highest in the germplasm BF Joy-014. The heaviest fruit (2.59 Kg) was observed in BF Joy-010. Only the germplasm BF Joy-011 exhibited very easy peeling quality and the germplasm BF Joy-009, BF Joy-010, BF Joy-012 and BF Joy-014 exhibited easy peeling quality, while the rest one exhibited medium peeling quality. Bitterness was absent in almost all the germplasm under study except BF Joy-010 and BF Joy-011, in which slight bitterness were present. The highest TSS (20%) was recorded in BF Joy-010. Maximum edible portion (40.89%) was recorded in BF Joy-011 followed by BF Joy-014 (36.97%) and the best yield (0.12 t/plant) was recorded in BF Joy-010 followed by BF Joy-014 (0.10 t/ha). The highest amount of vitamin-C (35.28 mg) was found in BF Joy-014. Total sugar (3.98%) was recorded maximum in BF Joy-010 and reducing sugar (2.17%) was recorded maximum in BF Joy-014. The highest amount of β-carotene (82.38 μg) was also found in the germplasm BF Joy-014. During off-season bearing period, fruit harvesting date ranged from 01 to 19 March 2017, in the germplasm BF Joy-009. On an average, the germplasm BF Joy-009 produced 7 bunches per tree and 8 fruits per bunch during the off-season. During off-season, individual fruit weight, 0.42 Kg; seedlessness and hard peeling quality; no bitterness in the fruit pulp; 16.37% TSS; 58.49% edible portion and 0.02 tons of yield/plant were recorded in the germplasm BF Joy-009.

Evaluation of existing superior year round palmyra palm line

An experiment was conducted to evaluate the year round performance of palmyra palm at the Agricultural Research Station, Pahartali, Chittagong. The germplasm produced flower three times, which were on January, March and August. The germplasm produced flower in March, bore seasonal fruits but flowering in rest of the two seasons (January and August) called year round. The plant produced off season fruits in the month of January and at the same time female flowers came out. In the month of January harvesting total number of fruits was 15. Individual fruit weight was 2.42 kg. The length and breadth of the fruit was 27.50 and 26.30cm, respectively. Fruit bearing was cluster type. Skin was very thin. Number of seed varied from 1 to 3 per fruit. Individual seed weight was 512 g. Total soluble solids were 12 %. Sweet smell was observed and no bitterness was found. Taste was very good. In the month of July harvesting total number of fruits was 28. Individual fruit weight was 1.49 kg. The length and breadth of the fruit was 25.50 and 26.21 cm, respectively. Rest of the characters was more or less similar in both months. Based on year round parameters like fruit size, shape, color yield and organoleptic taste the line BF Pah-001 was found promising.

Evaluation of exotic jamun germplasm

An experiment was carried out at the Horticulture Research Center, BARI, Gazipur during 2016-17 to evaluate an exotic jamun germplasm (SC-Ex001). Plant height, base girth and number of primary branches were 5.55 m, 69.51 cm and 4, respectively. The plant produced 18.50 kg fruit. Individual fruit weight was 5.55 g, edible portion was 81.08% having TSS 13.00%. The ripe fruit was black in colour.

Evaluation of jamun (*syzygium cumini)* in hilly area of rangamati

An experiment with four jamun germplasm was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2016-17. Significant variation was observed in growth, yield and yield contributing characters. The highest plant height, base girth and canopy was recorded from SC Rai-004 i.e 4.1 m, 55 cm and 4.16 × 4.03 m respectively. The highest number of fruits per tree (1733) as well as yield per plant (23.6 kg) was recorded in SC Rai-004 but the lowest fruits (870) found in SC Rai-008. On the other hand, the maximum fruit size (3.3 cm × 2.8 cm), individual fruit weight (14.2 g), flesh thickness (9.23 mm), edible portion (85. 2%) and TSS (18.4 %) were recorded in SC Rai-009. Fruits of all the genotypes were black in color, oblong in shape with flat fruit apex. The organoleptic taste of SC Rai-008 was very good. Based on fruit size, individual fruit weight, flesh thickness, edible portion, TSS (%), organoleptic taste and fruit yield genotype SCRai004, SC Rai-008 and SC Rai-009 was supposed to be superior

Survey, collection and evaluation of jamun germplasm

An experiment was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi to evaluate nine Jamun germplasm for superior traits during 2016-17 (survey on different area in Rajshahi, Natore and Pabna). Wide variations were observed among the germplasm. Maximum plant height was recorded from SC Raj-001 and SC Raj-005 and minimum in SC Raj-013. Highest base girth was observed in SC Raj-005 and lowest in SC Raj-004. The highest fruit weight of 15 gm was obtained from SC Raj-014 followed by SC Raj-013 (13 g). The maximum edible portion (86.67 %) was obtained from SC Raj-014 and SC Raj-016 followed by SC Raj-005 and SC Raj-015 (85 %) whereas the minimum edible portion (72.50%) was found in SC Raj-004. The highest TSS 18 % was obtained from SC Raj-013. Maximum yield per plant was recorded form SC Raj-005 (50 kg) followed by SC Raj-001 (47 kg). Minimum yield per plant was recoded in SC Raj-006 and SC Raj-014 (20 kg). Considering fruit quality, percent TSS, flesh type, edible portion and yield SC Raj-013 and SC Raj-014 in superior than other lines.

Evaluation of jamun germplasm at khagrachari

Twenty seven jamun germplasm were evaluated for their fruit characteristics at the existing plantation in the fruit orchard of HARS, BARI, Khagrachari during 2015-16 & 2016-17. The maximum size and weight of individual fruit was in SC Kha-006 and the minimum was in SC Kha-008. Out of twenty seven germplasms showed their superiority in respect of fruit size. The edible portion of the different germplasms also varied widely and ranged from 73.21% – 93.10%. The TSS % of the germplasms ranged from 12% -15.6%. **C**onsideration of fruit characteristics, edible quality, TSS (%), percent edible portion and yield potentialities, the germplasm SC Kha-005,SC Kha-007, SC Kha-008, , SC Kha-014 and SC Kha-015 were found promising.

Evaluation of indian dillenia germplasm

A 11 years old Indian dillenia accession (DI Jam-001) was evaluated during 2016-2017 at Regional Agricultural Research Station (RARS) to develop an Indian dillenia variety suitable for agro-climatic condition of Bangladesh. Evaluation of phonological and biochemical fruit analyses as well as of Eco physiological characteristics has been conducted. The accession under this study harvested on December, 2016. Greater number of fruits (300.00) was harvested with average fruit weight of 623.60 g. The total soluble solids in fruit flesh were 5.20% with good taste. Therefore, the accession can be an important source of germplasm for breeding and conservation of indian dillenia germplasm at Horticulture Research Centre of RARS, Jamalpur.

Evaluation of indian dillenia germplasm in hilly region

Three Indian dillenia germplasm were evaluated at the Hill Agricultural Research Station, Ramgarh during the year 2016. A wide variation was observed in growth, yield and yield contributing characters. The highest plant height and base girth was recorded from DI Ram-005 (25.10 m) and DI Ram-003 (206 cm) and the lowest was observed in DI Ram-002 in both the cases. The line DI Ram-003 produced the maximum number of fruits (597/plant) while heavier fruit (801.7 g/fruit) was produced by the line DI Ram-005. The maximum fruit yield (430.40 kg/plant) was obtained from the line DI RAM-005 and the lowest yield (106.21 kg/plant) was recorded in DI Ram-002. Considering yield and yield contributing characters the line DI RAM 005 was found superior.

Evaluation of indian dillenia germplasm

The present study was conducted at Regional Agricultural Research Station, Ishurdi, Pabna to evaluate the local Indian dillenia germplasm. Two germplasm were included in this station. There were differences among the germplasm studied regarding plant height, base girth, canopy spreading, number of branches per plant, number of fruits per plant and yield. The highest plant height, base girth and size of leaf was observed in case of DI Isd-001. DI Isd-001 was superior with bigger canopy size. Fruit weight, number of fruits per plant, fruit length, fruit diameter, % edible portion, TSS and yield (298.93 kg/plant) in all cases DI Isd-001 found superior.

***In-situ* evaluation and collection of superior burmese grape genotype**

Seven Burmese grape (*Baccaurea sapida* Muell. Arg.) germplasm (BS Nar-001, BS Nar-002, BS Nar-003, BS Nar-004, BS Nar-005, BS Nar-006 and BS Nar-007) were evaluated at the farmers' field of Shibpur, Narsingdi. Wide variation was observed in growth, yield and yield contributing characters in the all germplasm while harvesting period was found same (June-July). The highest plant height (12.12 m), base girth (0.22 m) and canopy spreading (E-W: 9.32 m and N-S: 9.15 m) were noted in BS Nar-002. The heaviest fruit (22.64 g) and maximum number of fruits/plant (3280) were manifested from BS Nar-002 while the lightest fruit (11.45 g) and minimum number of fruits/plant (1960) were obtained from BS Nar-006. Same trend of results were also observed in case of yield. The highest yield (88.75 kg/plant) was noticed from the germplasm of BS Nar-002 contrary, the lowest of that (46.15 kg/plant) was recored from BS Nar-006. Moreover, maximum edible portion (57.69 %) was also recorded from the fruits of BS Nar-002 while the lowest of that (38.48 %) was measured in the fruits of BS Nar-006. The highest total soluble solids (16.35%) was recored in the fruits of BS Nar-002 follwed by BS Nar-003 (15.83%) and the lowest of that was measured in the fruits of BS Nar-004 (14.03%). Flesh color and texture of all the germplasm were found off-white and juicy. This germplasm BS Nar-002 was also free from disease whereas the other germplasm were attacked by powdery mildew and sooty mould diseases but Chaper beetle was found common in all the germplasm. Considering growth, diseases and insect infestation, fruit characters, yield and yield contributing characters, the germplasm BS Nar-002 showed superiority over other germplasm.

Evaluation of wax jambu at narsingdi region

An investigation with three wax jambu (*Eugenia javanica*) germplasm was conducted at RHRS, Shibpur, Norsingdi during 2016 to 2017 where BARI Jamrul-1 was included as check with two collected germplasm (EJ Nar 001 and EJ Nar 002). The highest fruit weight (45.57g) was obtained from EJ Nar 002 and the lowest (9.04g) of that was recoreded from EJ Nar 001. Maximum TSS (5.12%) was manifested from the fruits of EJ Nar 002 follwed by BARI Jamrul-1 (4.40) and minimum of that (3.20%) was recoreded from the fruits of EJ Nar 001. The highest yield (64.46 kg/plant) was recored from the BARI Jamrul-1 follwed by EJ Nar 002 (56.51 kg/plant) while the lowest (16.55 kg/plant) of that obtained from EJ Nar 002. Fruits of all germplasm exhibited very attractive color, among them BARI Jamrul-1 was deep purple; EJ Nar 001 was bright pink and EJ Nar-002 was creamy white. BARI Jamrul-1 and EJ Nar-002 produced fruit once in a year but the germplasm EJ Nar-001produced fruit thrice in a year.

Evaluation of wax jambu germplasm

Six wax jambu germplasm were evaluated at RARS, Akbarpur, Moulvibazar during 2016-2017 where BARI Jamrul-2 was used as check with five germplasm (SS Akb-001, SS Akb-002, SS Akb-003, SS Akb-004 and SS Akb-005) collected from different parts of Sylhet region and were planted in 2010. The plants were fertilized with cowdung (10kg), urea (100g), TSP (100g), MP (100g) and gypsum (100g) in two equal splits, one at the onset and the other at the end of rainy season evry year. The highest fruit weight (66.67g) was recorded frim the plant of SS Akb-001 follwed by SS Akb-003 (58.33 g) while the lowest (33.33g) of that was manifested from BARI Jamrul-2. Number of fruits per plant was varied from 1070 (SS Akb-004) to 4762 (SS Akb-002). Total soluble solids was varied from 3.6 % (SS Akb-002) to 5.6 % (SS Akb-002) while in BARI Jamrul-2 it was 4.6 %. Fruit colour of SS Akb-001 was noticed creamy white while the colour of BARI Jamrul-2 was dark red.

Evaluation of cowa germplasm

An experiment was conducted at the Citrus Research Station (CRS), Jaintapur, Sylhet with seven cowa *(Garcinia cowa)* germplasm (GC Jai-001, GC Jai-003, GC Jai-004, GC Jai-009, GC Jai-014, GC Jai-016 and GC Jai-033). Each plant was fertilized with 20 kg Cow dung, 750 g urea, 500 g TSP, 400 g MoP, 250 g gypsum, 50 g zinc sulphate and 20 g Borax in two splits in circular trench (60 cm broad, 30 cm deep) one meter away from the trunk. First split was applied at the end of September and second after fruit setting. Two full cover spray with Bavistin 50WP @ 2 g/L was applied when the fruits were in pea and marble stage to avoid fungal infection on fruit.Wide variation was observed among the germplasm in terms of plant height, base girth, canopy spreading, number of fruits/plant, fruit weight, edible portion and TSS. Highest plant height (11 m), base girth (154 cm) and canopy size (E-W: 13 m and N-S: 12.9 m) were recorded in GC Jai-004. But maximum yield/plant (85.2 kg) was recorded in GC Jai-001. The highest fruit weight (45 g) was obtained in GC Jai-004 and GC Jai-033 but the largest fruit (4.5 cm × 4.2 cm) was found in GC Jai-033 followed by GC Jai-004 (4.1 cm ×3.4 cm) while the smallest of that was found in GC Jai-003 (3.0 cm ×3.6 cm). Maximum edible portion (40%) was recorded in GC Jai-004 but the highest TSS (17.3%) was found in GC Jai-003 while the highest number of fruit per plant (2130) was recorded from GC Jai-001.

Collection and evaluation of cowa germplasm

Cowa *(Garcinia cowa)* is an underutilized fruit in Bangladesh. Eleven cowa germplasm were evaluated (GC Rah-001, GC Rah-002, GC Rah-003, GC Rah -004, GC Rah- 005, GC Rah- 006, GC Rah-007, GC Rah-008, GC Rah-009, GC Rah-010 and GC Rah-011) at RARS, Rahmatpur, Barisal during 2016-2017. One year old seedlings of cowa genotypes were planted in July 2008 at a spacing of 3.5 m x 3.5m. Wide variation was observed in growth characteristics among the germplasm. The highest plant height (498 cm) was attained in GC Rah-007 and the lowest of that (240 cm) was found in in GC Rah- 010 (240 cm). The highest base girth (61 cm) was found in GC Rah-011 and the lowest of that (28 cm) was recorded from GC Rah 008. The highest leaf length (16.90 cm) was found in GC Rah-011 and the lowest of that (13.50 cm) was in GC Rah-008. The highest leaf breadth (5.72 cm) was found in GC Rah-009 and the lowest of that (3.35 cm) was recorded from GC Rah-010. The highest number of fruits per plant (1260) was manifested from the plant GC Rah-003 and the lowest of that (233) was obtained from GC Rah-011. The highest individual fruit weight (454.60 g) was found in GC Rah-010 while the lowest of that (33.00 g) was recorded in GC Rah-002. The highest yield was found in GC Rah-003 (51.16 kg/plant) and the lowest of that was noticed from GC Rah-011 (8.27 kg/plant).

Evaluation of dragon fruit germplasm

Eight dragon fruit germplasm (HC Joy-001, HC Joy-004, HC Joy-005, HC Jai-003, HC Jai-007, HU Jai-011, HU Jai-012 and HC Jai-014) were evaluated at Citrus Research Station (CRS), Jaintapur, Sylhet which were planted during January 2013. Each plant was fertilized with 20 kg cow dung, 200 g urea, 250 g of TSP, 150 g of MOP, 50 g of gymsum, 20 g Zinc sulphate and 10 g of boric acid. The plot was irrigated twice a month in dry period. Bavistin 50 wp was applied @ 2g/liter water for preventing foot and stem rot. Nnumber of side branches were found maximum (19) in HC Jai-003 and minimum (12) in HC Jai-011. Flowering duration was recorded from 4 may to 28 may in all germplasm. The highest number of fruits (21) was obtained from HC Joy-005. The heaviest fruit (397g) was obtained from HU Jai-012 with maximum (81.11%) edible portion. Considering all characters HU Jai-012 found promising among the studied germplasm.

Performance of dragon fruit germplasm at hill slope

An experiment was carried out at HARS, Khagrachari to find out the performance of three dragon fruit germplasm (HU Kha-001, HU Kha-002 and BARI Dragonfruit-1) in the hill slope. The highest fruit weight (390 g) was recorded from BARI Dragonfruit-1 followed by HU Kha-002 (303 g) but the minimum of that (213 g) was found in HU Kha-001. The highest number of fruits (24) per pillar (one pillar contain four plants) were harvested from BARI Dragonfruit-1 and the lowest of that (9) was noticed in HU Kha-001. The highest edible portion (87.81%) was obtained from BARI Dragonfruit-1, whereas the lowest (78.75%) of that was recorded in HU Kha-001. The maximum TSS (14%) was found in BARI Dragonfruit-1 and HU Kha-001 while the lowest (12%) of that was found in HU Kha-002. Considering flowering time and fruit bearing habit, fruit characteristics and yield, BARI Dragonfruit-1 was found superior over two collected germplasm. However, for commercial cultivation, it needs more study with economic analysis and marketing potentiality.

Evaluation of bael germplasm

An experiment was conducted at CRS, Jaintapur, Sylhet, during 2016 to 2017 with four bel germplasm(AM Jai-001, AM Jai-002, AM Jai-003 and AM Jai-004). Among the germplasm wide variation was observed in different characters. The heaviest fruit (1136.24 g) was obtained from AM Jai-002 while lightest (734.75 g) of that was found in AM Jai-004. Maximum fruit size was obtained from AM Jai-002 (14.5 cm ×11.5 cm) followed by AM Jai-001 (13 cm ×10 cm) while the smallest fruit (9.3 cm ×8.9 cm) was found in AM Jai-003. The highest edible portion (74.90 %) was recorded from AM Jai-002 while the lowest (58.52 %) of that was found in the fruits of AM Jai-004. Maximum number of seed (65) was recorded in AM Jai-002 and minimum (42) was found in AM Jai-004. Maximum TSS (41.4%) was recorded in AM Jai-001 while the minimum (33%) of that was recorded in AM Jai-003. The highest number of fruits (115) were recorded in AM Jai-001 while the lowest (75) of that was found in AM Jai-002. In case of rind thickness, the thickest rind (0.33 cm) was noticed in AM Jai-002 on the other hand, the thinnest rind (0.24 cm) was manifested frim AM Jai-003 (0.24 cm). The highest yield/plant (94.13 kg) was recorded in AM Jai-001 while the lowest of that (70.54 kg) was weighted in AM Jai-004.

Evaluation of bael in hilly area of Rangamati

An experiment was conducted at Hill Agricultural Research Station (HARS), Raikhali, Rangamati during 2016-17 with two bael germplasm (AM Rai-002 and AM Rai-003). The highest number of fruits per plant (21) were obtained from AM Rai-003 while the germplasm AM Rai-002 produced 14 fruits per plant. Same trend of results were also found in individual fruit weight and edible protion. The highest fruit weight (1450 g) was manifested from AM Rai-003 with maximum edible portion (70.7 %) and TSS (37.7%) while the lowest of those (fruit weight, edible portion and TSS were 1380, 61.40% and 28.9%, respectively) were found in AM Rai-002. Bitterness was found completely absent in the pulp of AM Rai-003, while bitterness was found in the pulp of AM Rai-002. Considering the edible portion, TSS%, organoleptic taste and other parameters, the performance of AM Rai-003 was found superior compared with AM Rai-002.

Evaluation of bael genotypes

An experiment was conducted at Regional Agricultural Research Station, Burirhat, Rangpur during 2016-17 with a view to developing high yielding variety of bael. Seventy two genotypes of bael were evaluated in this study. Among the seventy two genotypes, only 49 genotypes were produced fruit in this season. Flowering time of different genotypes was observed in all genotypes from 4^{th} week of April to 1^{st} week of June. Early flowering (4th week of April) was observed in AM Bur-50 and late flowering (1st week of June) was observed in AM Bur-054, AM Bur-055, AM Bur-058, AM Bur-059, AM Bur-060, AM Bur-061, AM Bur-062, AM Bur-065, AM Bur-066, AM Bur-067, AM Bur-069, AM Bur-071 and AM Bur-073. Harvesting was done from 1st week of March to 4^{th} week of April. Maximum number of fruits per plant (35) were obtained from AM Bur-037, whereas minimum number of fruit (1) was found in AM Bur-20, AM Bur-41, AM Bur-40, AM Bur-57 and AM Bur-058. The highest yield (41.85kg/plant) was obtained from AM Bur-044 while the lowest (0.30kg/plant) of that was recorded from AM Bur-50. Considering yield and quality, the genotypes AM Bur-044, AM Bur-037 and AM Bur-031 were found promising.

Collection and evaluation of existing bael germplasm

An experiment was conducted at the Regional Horticulture Research Station, Chapainawabganj during 2016-17 including 22 bael germplasm to find out a good genotype of bael for the commercial cultivation.Germplasm were collected from different places of Chapainawabganj and Rajshahi district. Nineteen germplasm produced flowers and fruits in this year. A wide variation was observed among the germplasm regarding growth, fruit and tree characteristics. Among the fruit characteristics, fruit weight varied from (650-2940 g), fruit length (6.8-50.0 cm), fruit breadth (10.6-53.2 cm), pulp weight (415-2267 g), fibre weight (34-90 g), seed weight (11-45 g) and TSS (25-36 %). Fruit yield per hectare was recorded the highest from AM Cha-01 (19.8 ton) and the lowest from AM Cha-011 and 12 (1.0 ton). Among the germplasm only two germplasm (AM Cha-008 and AM Cha-009) produced early fruits (15 March) and rest of them were noticed as late harvested (mid April to end of April). Considering over all assessment 9 germplasm (AM Cha-002, AM Cha-004, AM Cha-006, AM Cha-09, AM Cha-010, AM Cha-012, AM Cha-013, AM Cha-015 and AM Cha-020) have been found as promising. The available variability for various traits in bael genotypes can be utilized for improvement of this under utilized fruit. Genotypes having less seeds and mucilage content, less fibre content and better aroma can be used for improvement of this native fruit. Superior germplasm can be release as a variety for commercial cultivation. Among the genotypes, AM 005 has been released as BARI Bael-1.

Evaluation of phalsa (*grewia asiatica l.*) in hilly area of rangamati

An experiment was conducted at the Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2016-17. Four germplasm (GA Rai-001, GA Rai-002, GA Rai-003 and GA Rai-004) were evaluated in this study. Maximum number of fruits per plant (13800) were manifested from GA Rai-002. The highest fruit length (9.28 mm) was obtained from GA Rai-002. The highest fruit yield (3.3 t/ha) was also obtained from GA Rai-002 on the other hand highest TSS (25.6 %) was recorded in the genotype GA Rai-004. Each fruit contained two seeds and fruits were harvested on May from all germplasm. Considering the number of fruits per plant, fruit length, fruit yield and other qualitative characters the genotype GA Rai-002 was found promising.

Evaluation of phalsa germplasm *(grewia asiatica)*

One germplasm of phalsa (GA Raj-001) was evaluated at Fruit Research Station, Binodpur, Rajshahi during 2016-2017. Germplasm (GA Raj-001) was a small spreading tree having plant height 9.9 m and base girth 0.95 m. The yellow flowers were born in dense cymes in the leaf axils during March to May. The fruit was round, drupe and become dark purple when ripe. The flesh color was light greenish white. The length and breadth of the fruit were 1.03 cm and 1.01cm, respectively. Length of peduncle was 2-3 cm. Fruit flavor was slightly astringent. Weight of fruit, seed and flesh of 100 fruits was 49g, 7.98 g and 41g, respectively. The edible portion and TSS was 84% and 23.9%, respectively. Number of seed per fruit was 1-2. Opaque, brown, round or hemispherical seed showed low seed shattering. The growth condition and fruit characteristic of the germplasm was satisfactory.

Evaluation of bilimbi germplasm

Two selected germplasm of bilimbi viz. AB Akb-001 and AB Akb-002 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar during 2016-17. Maximum fruit weight (41.21 g), fruit length (8.64 cm), fruit breadth (3.10 cm), number of seed per fruit (9.81) and the highest number of fruits per plant (1255) were recorded from AB Akb-001 but maximum number of seed per fruit was recorded in AB Akb-002. The highest TSS (3.76 %) was recorded in AB Akb-001 and the lowest (3.22 %) of that was recorded in AB Akb-002.

Evaluation of rose apple germplasm

One germplasm (SJ Akb-001) of rose apple (*Syzygium jambos*) was evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar during the year 2016-17. Plant height, plant canopy and base girth was recorded at the pick of fruit maturity level. Total number of fruits (1726) are relatively higher or up to satisfactory level. The fruits are oval in shape having 21.14 g average weight and 3.76 cm diameter with 0.68 cm flesh thickness and 2.22 g weight of each seed. TSS of fruits was found 13.06% which indicates sweetness of fruit. The germplasm was found good in terms of plant morphological and fruit characteristics.

Evaluation of sapota (*achras sapota*) germplasm

Seven germplasm of sapota (AS Rah-001, AS Rah-002, AS Rah-003, AS Rah-004, AS Rah-005, AS Rah -006 and AS Rah-007) were evaluated at the RARS, Rahmatypur, Barisal. Wide variation in growth characteristics among the germplasm were found. Among the germplasm, the plant height was ranges from 8.80 m to 6.85 m. The highest plant height was attained in AS Rah-001 (8.80m) and the lowest of that was found in AS Rah-06 (6.85m). The total number of fruit per plant varied from 190 to 315. The height number of fruit per plant (315) was found in AS Rah-006 and the lowest of that (190) was manifested from AS Rah-002 (190). The heaviest fruit (76.72g) was harvested from AS Rah-002 and the lightest fruit (58.36g) were obtained from AS Rah-004. The highest yield (21.75kg/plant) was found in the germplasm AS Rah-006 and the lowest yield (14.58 kg/plant) was found in AS Rah-002.

Evaluation of advance sapota germplasm

Three sapotagermplasm (AS Ram- 001, AS Ram-004 and AS Ram- 005) were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2017. There were a lot of variability in respect to plant height, number of branch, spread of plant, fruit size, single fruit weight and TSS (%). The highest plant height (12.1 m) was recorded from AS Ram-004 and maximum base girth (145 cm) was found from same plant. Maximum number of main branches (4.0/plant) was found from AS Ram-001. The germplasm AS Ram-001 produced the highest canopy with maximum E-W spread (13.80 m) and the highest canopy with maximum N-S spread (11.70 m). The germplasm AS Ram-005 produced the maximum number of fruits (506/plant) while bigger fruit (179.3) produced by the AS Ram-001. The maximum fruit yield (54.58g/plant) was recorded from the AS Ram-001 which was closely followed by the AS Ram-005 (53.63 kg/plant). The highest TSS (20.6%) was recorded in AS Ram-004. The results indicated that the germplasm AS Ram-001 was found superior than others.

Evaluation of golden apple germplasm in the hilly region

Seven Golden apple germplasm (SD Ram-001, SD Ram-002, SD Ram-003, SD Ram-004, SD Ram-005, SD Ram-006 and SD Ram-007) were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2016. A lot of variability was observed in respect to plant height, number of branch, spread of plant, fruit size, single fruit weight and edible portion (%). The highest plant height (8.5 m) was recorded from SD Ram-003 but maximum base girth (126 cm) was found from SD Ram 001 and maximum number of main branches (5/plant) also noticed in same germplasm. The line SD Ram-001 produced the highest canopy (7.9 m) in E-W direction but N-S spread was found maximum (7.6 m) in SD Ram-003. The germplasm SD Ram-001 produced the maximum number of fruits (3380/plant) followed by SD Ram-002 (3015/plant) and the heaviest fruit (102.6 g/fruit) produced by

SD Ram-002. The maximum fruit yield (309.33 kg/plant) recorded from SD Ram-002 followed by SD Ram-001 (283.92 kg). Though number of fruits was less in SD Ram-002 than SD RAM 001 but fruit size was heavier in SD Ram-002.The highest edible portion (%) was recorded from SD Ram-002 (79.0%) and the lowest (49.4%) of that was found in SD Ram-004. TSS (%) was almost similar in all germplasm and the range is 6.24% to 6.60%. Considering yield and yield contributing characters SD Ram-001 and SD Ram-002 were found superior than others.

Evaluation of monkey jack germplasm in hill region

Five germplasm of monkey jack fruits (AL Ram-001, AL Ram-002, AL Ram-003, AL Ram-004 and AL Ram-005) were evaluated at Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2017. Each of the plants were fertilized with cowdung 10 kg, 150, 60 and 120gm NPK respectively in two installments at the beginning and the end of the rainy season. Intercultural operations such as weeding, mulching, irrigation were done as and when necessary.No plant protection was taken as there was no insect pest visible during the study period. Among the five germplasm,fruits were found from threeplants in 2017. The germplasm AL Ram-001 had the maximum tree size (E-W: 7.6m and N-S: 8.2m). Plant height (12.1m) and base girth (199.2 cm) were also maximum in the same germplasm. Profuse bearing was observed in AL Ram-001. The same line gave 322 fruits with average fruit weight (186.2g).The highest yield (59.96 kg/plant) was found from AL Ram-001 and TSS was found maximum (16.6%) in same germplasm. The skin colour of all fruits were attractive yellow. A well ripen fruits seems to be soft enough and sour sweet in taste.

Performance of tisa germplasm in the hilly region

Five germplasm of Tisa (*Pouteriacampechiana*) fruits (PC Ram-001, PC Ram-002 PC Ram-003, PC Ram-004 and PC Ram-005) were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2017. The line PC Ram-003 had the maximum tree volume ($31.55m^3$) followed by PC Ram-005 ($29.37\ m^3$) while the lowest was found in PC Ram-001 ($10.98\ m^3$). Profuse bearing was observed in the line PC Ram-003 providing continuous flowering and fruiting round the year, mainly March and April. The same line gave 171 fruits with medium single fruit weight (111.4.4 g) that yielded 19.04 kg/plant. All the fruits had a good keeping quality (21 days) with very high edible portion (92.4%) and TSS was found same in all germpalsm (22.5%). The skin color of the fruits was attractive yellow with orange colored flesh. A well ripen fruits seems to be soft enough but not juicy which was comparable to the yolk of boiled egg but sweet in taste. The result indicated that the line PC Ram-003 showed better performance and this germplasm will be submitted for variety development.

Evaluation of jaboticaba germplasm in hilly region

Five germplasm (EC Ram-001, EC Ram-002, EC Ram-003, EC Ram-004 and EC Ram-005) of Jaboticaba *(Eugenia cauliflora)* fruits were evaluated at Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during April, 2017. Among the five germplasm, four bears flower in 2017. The line EC Ram-003 had the maximum tree size (E-W: 291m and N-S: 281m). Profuse fruit bearing observed in the line EC Ram-002. The same line produced 325 fruits with average fruit weight (6.1g).The highest yield (2.02 kg/plant) was found from EC Ram-004 and EC Ram-005 and TSS was found maximum (11.9%) in EC Ram-002 and EC Ram-003. The skin colour of all the fruits were found attractive black. A well ripen fruits seems to be soft enough but not juicy and sweet in taste.

Evaluation of cashewnut germplasm

Eight cashew nut (*Anacardium occidentale*) germplasm (AO Hat-001, AO Hat-002, AO Hat-003, AO Hat-004, AO Hat-005, AO Hat-006, AO Hat-007 and AO Hat-008) were evaluated at RARS, Hathazari during 2016-17. Flowering period was observed during the month of February in all germplasm and harvesting was done during the month of May. Maximum fruits per plant (1000) were found from AO Hat-004 whereas minimum fruits per plant (236) were found from AO Hat-008. The highest yield per plant (35.56 kg) was found in AO Hat-004 followed by AO Hat-006 (35.36 kg). Maximum nut yield per plant (4.29kg) was found in AO Hat-006 followed by AO Hat-007 (3.97kg).

Minimum yield per plant (12.14kg) and minimum nut yield per plant (1.4kg) was found in AO Hat-003. Nut weight was higher (6.6g) in AO Hat-002 and AO Hat-006 followed by AO Hat-008 (6.4g). Considering nut yield and yield contributing characteristicsAO Hat-004 and AO Hat-006 was found to be promising than others.

Evaluation of collected cashewnut germplasm at hars khagrachari

An experiment was carried out at HARS, Khagrachari with two cashewnut germplasm (AO Kha-001 and AO Kha-002) in the hill slope of Khagrachari. Number of fruits per plant was found maximum (655) in AO Kha-002 and minimum was found in AO Kha-001 (570). The highest apple weight (36.8 g) was recorded in AO Kha-002 and the lowest in AO Kha-001 (570 g). Apple length was found maximum (4.7 cm) in AO Kha-002 and the minimum (4.3) in AO Kha-001. The highest apple weight/plant (24.14 kg) was recorded from AO Kha-002 followed by AO Kha-001 (15.04 kg). The maximum TSS (11.5%) of apple was found in AO Kha-002 and the lowest (10.8%) of that was found in AO Kha-001. Individual nut weight was observed maximum (5.4 g) in AO Kha-002 and minimum (4.2 g) of that was found in AO Kha-001. Nut length was recorded maximum (3.05 cm) in AO Kha-002 and the lowest (2.92 cm) of that was observed in AO Kha-001. The maximum nut weight/plant (3.54 kg) was recorded from AO Kha-002 followed by AO Kha- 001 (2.40 kg). The edible portion was found maximum (37.5%) in AO Kha-002 and the lowest of that (36.2 %) was noticed in AO Kha-001.

Evaluation of promising olive germplasms at hathazari

Twelve olive (*Olea europaea)* germplasm (OE Hat-001, OE Hat-002, OE Hat-003, OE Hat-005, OE Hat-006, OE Hat-010, OE Hat-013, OE Hat-016, OE Hat-017, OE Hat-018, OE Hat-019 and OE Hat-021) were evaluated at RARS, hathazari to observe their performance as well as their genetic variations. A wide genetic variations were observed among different physio-morphological parameters studied. The highest (248 cm) base girth was observed in OE Hat-002. Maximum number of main branches (4) were found in OE Hat-016 and OE Hat-021. The line OE Hat-002 was the tallest (12.0 m) among the germplasm. The same line produced the highest (12.7m E-W x 16.2m N-S) canopy among the genotypes.Significant variation was found in yield and yield contributing characters in all germplasm. The germplasm OE Hat-017 produced maximum number of fruits (13824). The highest single fruit weight (30.8 gm) was found in OE Hat-010. The highest (259.89 Kg) yield was recorded from the line OE Hat-017. The highest edible portion (88.24 %) was found in OE Hat-002 and the highest TSS (9.73 %) was manifested in OE Hat-018.

Collection and evaluation of custard apple genotypes

An experiment on collection and evaluation of custard appel germplasm was conducted at the Regional Horticulture Research Station, Chapainawabganj during 2016-17. Sixteen genotypes were collected from five upazils of Chapainawabganj district. A wide variation was observed among the germplasm regarding fruit weight, fruit shape and harvesting time. Among the genotypes, AR Cha-006 produced heavier fruits (290 g) and the minimum (90 g) from AR Cha-004. Fruit length of different genotypes varied from 4.9 cm (AR Cha-004) to 7.9 cm (AR Cha-006), while the fruit breadth was varied from 5.3 cm (AR Cha-004) to 7.5 cm (AR Cha-011). Total soluble solids of different genotypes were varied from 16-25%. The highest TSS (25%) was recorded in AR Cha-006 and AR Cha-014 and the lowest TSS (16%) was obtained from AR Cha-001. Eating quality and fruit attractiveness was also satisfactory for most of the genotypes.

Collection and evaluation of custard apple germplasm

Fruit characteristic of thirteen custard apple germplasm were studied at the Fruit Research Station, Binodpur, Rajshahi during the fruiting season of 2016 (August-September). The result indicated that wide range of diversity existed in fruit weight, pulp weight, TSS, pulp content and skin weight etc.The weight of fruit varied from 68.40g to 150.00g. The highest fruit weight (150 g) was observed in AS Bin-004 followed by AS Bin-011 (122.5 g), AS Bin-010 (121g), AS Bin-012 (116.20 g) and AS Bin-002 (115.00 g). The lowest fruit weight (68.4 g) was recorded in AS Bin-006. The skin weight was the highest (68.83) in AS Bin-004. The highest TSS (25%) was found in AS Bin-002, the lowest (18%) of that was found in AS Bin-006 & AS Bin-009. The fruit shape varied from heart to roundish. The results revealed that AS Bin-004, AS Bin-011, AS Bin-012 and AS Bin-002 were found superior.

Collection and evaluation of custard apple germplasm

A study was carried out at Horticulture Research Center, Regional Agricultural Research Station, Jessore during 2016-17 to collect and evaluate the custard apple germplasm. Only five germplasm were collected in 2008 and planted at Horticultural Research Center, RARS, Jessore. Maximum number of fruits/plant (22) was produced by the germplasm CA Jes-003 followed by CA Jes-001 (20) and minimum (10) was obtained from the germplasm CA Jes-004. Individual fruit weight was found maximum (120 g) in CA Jes-004 and minimum (104 g) was recorded in CA Jes-001.The highest percentage of edible portion 60.90 % was found in the germplasm CA Jes-005 which was closely followed by CA Jes-004 (60.83 %) and the lowest edible portion (53.33 %) was manifested in CA Jes-002. Minimum number of seeds per fruit (16) were recorded in CA Jes-005 while the maximum number of seeds per fruit (25) were obtained in CA Jes-003.

Collection and evaluation of some bullock's heart genotypes

An investigation was carried out at RHRS, Chapai Nawabganj during 2017 to find out superior genotypes of bullock's heart (*Annona reticulata* L). Fruits of seven genotypes were collected from Chapai Nawabganj. Fruits were analyzed and significant variation was observed in respect of fruit length, fruit breadth, as well as qualitative parameters like pulp content, edible portion, TSS and eating quality. Considering the fruit data the genotypes AR Cha-015, AR Cha-019 and AR Cha-021 were found superior for further study.

Collection and evaluation of some pomegranate germplasm

Five germplasm of pomegranate were evaluated at RHRS, Chapai Nawabganj in the year of 2017. Early flowering (mid-April) was observed in PG Cha-002, PG Cha-004 and PG Cha-008 while late flowering (mid-May) was noticed in PG Cha-012 and PG Cha-013. The highest number of fruits (28) was recorded in PG Cha-002 followed by PG Cha-004 (22) while the lowest number of fruits per plant (10) was produced in PG Cha-013 followed by PG Cha-012 (13).

Evaluation of longan germplasm

An experiment was conducted at Regional Agricultural Research Station, Burirhat, Rangpur during 2016-17 with a view to find out suitable longan germplasm for releasing as variety. Seven longan germplasm and BARI Ashfal-1 (as check) were included in this study. The saplings were planted on July 3, 2006 with a spacing of 4 x 4m. Manures and fertilizers were applied as per recommendation of BARI Krishi Projukti Hatboi (5th edition, 2011). The average fruit weight was found maximum (5.20 g) in NL Bur-002 followed by NL Bur-006 (4.60 g) while the minimum of that (3.30 g) was found in NL Bur-007. The highest seed weight (1.64g) was recorded from BARI Ashfal-1followed by NL Bur-002 (1.62 g), while the lowest sed weight (0.42g) was manifested in NL Bur-004. Aril content was found higher (46.05%) in NL Bur-004 followed by NL Bur-002 (39.23%), while the lowest (27.75%) was found in BARI Ashfal-1. TSS was found higher (23.50%) in NL Bur-003 followed by NL Bur-002 (22%), while the lowest of that (12%) was found in NL Bur-001.

Project II : Propagation Technique

Effects of time and variety on grafting in litchi

An experiment was conducted at the Fruit Research Farm of Horticulture Researh Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during November 2016 to May 2017 to study the effects of time and variety as scion on grafting in litchi. There were two factors in the experiment viz. time and scion variety as scion of litchi. Scion of 3 litchi varieties namely BARI Litchu-2, BARI Litchu-3 and BARI Litchu-4 were taken for grafting in the months of November, December, January, February, March, April and May. Time of grafting and scion variety alone and in combination influenced the success of grafting, days required to budbreak and shoot length. The highest success was achieved in May grafting with the scion BARI Litchu-4 (90.0%) followed by BARI Litchu-2 (80.0 %). The lowest success was observed in BARI Litchu-3 in November (20.0%).

Propagation of burmese grape through air layering to avoid longer time to produce fruit

Two types of burmese grape layers obtained from two and five years old branches were planted at RHRS, Narsingdi in August 2012. Growth habit of layers propagated from branches of different ages (2 and 5 years) was noticed central. Growth rates of layers were found identical and started to produce flowers and fruits in the following year of planting. After five years from planting maximum base girth (22.23 cm) was noticed in the plants propagated from five years old branches while the lowest base girth (17.41 cm) was recorded in plants derived from two years old branches. Weight of total fruits obtained from the plant propagated from two years old branches was recorded 1205.60 kg while it was 7.88 ton in the plants propagated from five years old branches in 2017. The growth, yield and yield contributing characters of the plants propagated from the five years old branches was higher compared to plants propagated from the two years old branches. The plants derived from seed were noticed in gestation condition and failed to produce any fruit. It was concluded that vegetative propagated plants of older branches reduce the gestation period than seed propagated plants.

Effect of different rootstocks on survival of mandarin, sweet orange and pummelo

An experiment was conducted to find out the effect of different rootstocks like Rough lemon, Kalamanshi and pummelo on survival of mandarin, sweet orange and pummelo at Regional Agricultural Research Station, Hathazari, Chittagong during 2016-17. Rough lemon required minimum days (20.23) to bud break and maximum days to bud break was noticed in pummelo (22.88). Maximum survivability of mandarin grafts were found in Kalamunsi (100%) and minimum (60%) was in pummelo. Maximum number of leaves and shoots was found in pummelo (55.33 and 7.3, respectively). Maximum shoot length (12.33 cm) was found in Kalamunsi. Pummelo required minimum days (21.31) to bud break and maximum days to bud break was found in Rough lemon (22.42). Maximum survivability of sweet orange grafts were found in Kalamunsi (100%) and minimum (80%) was in Rough lemon. Number of leaves, number of shoots, Shoot length and diameter was found maximum in Rough lemon (35.67, 4.6, 19.18 cm and 0.30 cm, respectively).Pummelo required minimum days (20.89) to bud break and maximum daysto bud break required in Rough lemon (22.48). Maximum survivability of pummelo grafts were found in Kalamunsi and pummelo (100%) and minimum (90%) was noticed in Rough lemon. Maximum number of leaves and shoots was found in pummelo (27.8 and 4, respectively).Maximum shoot length (9.66 cm) was found in Kalamunsi. Maximum grafting success (100%) was found in Kalamunsi rootstock in case of Mandarin, Sweet orange and Pummelo. All the plants are now in vegetative stage (10 months old). Observations will be continued and final findings will be made after 3-5 yeard study.

Effect of different grafting methods on survival of sweet orange

An investigation was carried out at RARS, Hathazari, Chittagong to identify appropriate method of grafting for maximizing survivability of sweet orange during 2016-17. Three methods viz. veneer, cleft and side grafting was studied. Among the three methods, Cleft grafting required minimum days (22.03) to bud break and maximum survivability (81.7%) was found in this method of grafting . On the other hand, side grafting required maximum daysto bud break (25.52) and minimum survivability (67.5%) of sweet orange grafts. Among the grafting methods Cleft grafting was found suitable for survival of sweet orange.

Performance of grafted and seedling plants of velvet apple var. bari bilati gab-1

An experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2016 to observe the performance of grafted and seedling plants of BARI Velvet apple-1. Average plant height (1.24 m), number of branches/plant (8.80), base girth (19.1 cm) were found from grafted plant while in the seeded plant, average plant height, number of branches/plant, base girth were 4.67m, 6 and 16.4 cm, respectively. The higher number of fruits (24.4/plant) was obtained from grafted plant compared to seeded plant (20.0/plant). Qualitative fruit characters were found almost same in both grafted and seeded palnts.

Project III: Cultural Management

Growth, yield and quality of mango as influenced by fertilizer and irrigation

Yield and quality of mango as influenced by fertilizer and irrigation were studied at the Fruit Research Farm of Horticulture Research Centre, BARI, Joydebpur, Gazipur during the period from August 2016 to July 2017. Three various levels of fertilizer (100 % of the fertilizer dose (Cowdung: 25 kg; N: 230.41 g, P: 50.00 g, K: 100.00 g, S: 35.97 g, Zn: 3.60 g, B: 3.40 g), 175 % of the fertilizer dose, 250 % of the fertilizer dose) and control along with two levels of irrigation (irrigations one at flowering stage and another one at pea stage of fruit and irrigations at an interval of 10 days up to maturity of fruit) were included in the study as treatments. The treatments; 250 % of the fertilizer dose and 175 % of the fertilizer dose produced identical but highest number of panicles per plant (327, 322) as against the lowest number (215) in control. Higher number of panicles per plant (297) was noticed in the treatment irrigations at an interval of 10 days up to fruit maturity. At harvest on 14.07.2017, plants treated with 250 % of the fertilizer dose resulted in maximum number of fruits per panicle (1.06). Plants irrigated at an interval of 10 days up to maturity of fruit exhibited highest number of fruits per panicle at harvest (0.91). Maximum number of fruits (196/plant) and yield (73.5 kg/plant) was harvested from the plants treated with 250 % of the fertilizer dose as compared to minimum (81/plant and 28.6 kg/plant, respectively) in the control. Maximum number of fruits (160) and yield (61.7 kg) per plant was observed in the treatment irrigations at an interval of 10 days up to maturity of fruit compared to minimum fruits (145) and yield (53.1) in two irrigations; one at flowering stage and another one at pea stage of fruit. Plants received 175 % of the fertilizer dose along with irrigations; one at flowering stage and another one at pea stage of fruit produced the biggest fruit (410.2 g)

Organic production of mango

An experiment with three organic fertilizers i.e. vermicompost, tricocompost and cowdung along the control (no fertilizer) was carried out at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur during September 2016 to July 2017 to produce safe and quality fruit**.** The treatment vermicompost had the longest terminal shoot (14.9 cm) and maximum number of leaves per terminal shoot (9.7 cm) as compared to the shortest shoot (8.4 cm) and minimum number of leaves per terminal shoot (8.4 cm) in cowdung treatment. Number of fruit set per panicle on 19.03.17 was recorded maximum (12.3) in cowdung compared to that of control (6.7). During harvest, except control, all the treatments exhibited superior but identical number of fruits per panicle. Date of harvest in all the treatments was demonstrated same on 1 July 2017. All the treatments resulted in higher but identical number of fruits per plant compared to minimum fruits in control. Tricocompost (449.4 g) produced the biggest fruit identical to that of cowdung (369.1 g) g). Control produced the smallest fruit (369.1 g). Edible portion ranged from 69.5% in control to 74.4% in tricocompost and TSS ranged from 16.3 % in cowdung and 17.4% in vermicompost. Maximum yield was recorded in the treatment tricocompost (48.3 kg/plant). Untreated control manifested minimum yield (21.7 kg/plant).

Integrated package development for growth regulator, fertilizer and irrigation in mango

An experiment to develop an integrated package with growth regulator, fertilizer and irrigation in mango was performed at the Fruit Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during September 2016 July 2017. BARI Aam-3 was used in the study as variety. The experiment was laid out in a Randomized Complete Block Design with 3 replications. The treatments were T_1 : 175% of the fertilizer dose; N: 403.2 g, P: 87.5 g K: 175.0 g, S: 62.9 g, Zinc: 6.3 g and Boron: 5.95 g + Four irrigations at an interval of 10 days, starting from full bloom + [2, 4-D 12 ppm + Urea at 2% (two sprays; one at pea stage and another one at marble stage)];

T_2 : 175% of the fertilizer dose + Four irrigation at an interval of 10 days starting from full bloom + [2, 4-D 12 ppm (two sprays) one at pea stage and another one at marble stage)]; $T_{3:}$ 175% of the fertilizer dose + Four irrigation at an interval of 10 days starting from full bloom + [Urea at 2% (two sprays) one at pea stage and another one at marble stage)] and T_4 : Control (water spray). The treatment $T_{3:}$ 175% of the fertilizer dose + Four irrigation at an interval of 10 days starting from full bloom + [Urea at 2% (two sprays) one at pea stage and another one at marble stage)] manifested maximum fruit set per panicle (12.5) on 20.03.17 compared to minimum fruit set (9.7) in control. Number of fruits per panicle at harvest on 09.07.2017 was noted highest in the same treatment $T_{3.}$ The treatment $T_{3:}$175% of the fertilizer dose + Four irrigation at an interval of 10 days starting from full bloom + [Urea at 2% (two sprays) one at pea stage and another one at marble stage)] exhibited maximum number of fruits (448) as well as yield (72.6 kg/plant) compared to those of control (282, 45.8 kg/plant).

Effect of fertilizer on flower and fruit drop in mango

The experiment to investigate the effects of fertilizer on flower and fruit drop in mango was carried out at the Fruit Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during September 2016 July 2017. BARI Aam-3 was included in the study as variety. Three doses of fertilizers i.e. 100 % [N: 230.41 g, P: 50.00 g K: 100 g, S: 35.97 g, Zinc: 3.60 g and Boron: 3.40 g], 175 %, 250 % of the fertilizer dose and control (no fertilizer) along with 4 irrigations at an interval of 10 days starting from full bloom in each treatment were included in the study. Plants treated with 250 % of the fertilizer dose and 4 irrigations at an interval of 15 days resulted in maximum plant height and canopy spread (N-S and E-W). At harvest, the highest fruits per panicle were recorded in the plants treated with 250 % of the fertilizer dose and 4 irrigations at an interval of 10 days starting from full bloom. Control plants resulted in minimum number of fruits per panicle at harvest. The parameters fruit weight, fruit length, fruit diameter, fruit thickness, edible portion and TSS did not have any significant influence due to fertilizer. The treatments 250 % and 175% of the fertilizer dose with 4 irrigations each at an interval of 10 days starting from full bloom resulted in identical but maximum number of fruits per plant (438, 405) and yield (56.3, 51.6 kg/plant) over control (280, 33.0 kg/plant).

Effect of salinity on growth, nutrient contents and biochemical parameters of seedlings of four citrus rootstocks

In order to find out the salt tolerant citrus rootstocks a pot experiment was conducted during the period from May to July 2016 with four citrus rootstocks and four levels of saline water at the greenhouse of Pomology Division, HRC, BARI, Gazipur, Bangladesh. The study was set up by following the completely randomized design with six replications. Six month old uniform and vigorous seedlings of four citrus rootstocks i.e. Pomelo (*Citrus maxima*), Rough lemon (Citrus jambhiri), Cleopatra mandarin (*Citrus reshni*) and Calamansi (Fortunella japonica) were irrigated for three months twice a weekly (250 ml water/irrigation) with four different concentrated saline water (made by dissolving raw NaCl in distilled water) i.e. normal water (control), 3 dSm^{-1}, 9 dSm^{-1}, and 16 dSm^{-1} saline water. After three months from the beginning of the study the seedlings were harvested and the recorded data were analyzed by using the ANOVA technique of STAR 2.0.1 (Statistical Tool for Agricultural Research) developed by IRRI, while the means were separated by Fisher's Least Significant Difference (LSD) test. The results showed that seedlings of all citrus rootstocks were significantly ($P<0.001$) affected by the application of different concentrated saline water as a means of irrigation water. All the growth parameters such as survivability percentage of seedlings, plant height, shoot diameter, leaf area, dry weight of roots and shoots were found decreased with increased levels of salinity. Results of the growth parameters revealed that seedlings of Cleopetra mandarin were the least affected followed by seedlings of Pomelo, while the worst effect was observed in seedlings of Calamansi followed by seedlings of Rough lemon. All the biochemical parameters (chlorophyll *a*, chlorophyll *b* and total chlorophyll) were decreased with increased salinity except proline content and the highest amount of proline (7.48±0.19 mg/g leaf fresh weigh) was measured in the seedlings of Cleopetra mandarin under irrigation of 16 dSm^{-1} saline water while under irrigation of normal water all rootstocks produced the lowest amount of proline (0.46±0.02 to 0.53±0.05 mg/g leaf fresh weigh) non-significantly. The study also revealed that the seedlings of Cleopetra mandarin were found less accumulator of Na and Cl while the seedlings of Calamansi accumulated the highest amount of Na and Cl and this result significantly altered the other nutrient contents as well. The practical implication of this study can be summarized in terms of salinity tolerance by the following order: seedlings of Cleopetra mandarin>Pomelo>Rough lemon>Calamansi.

Development of fertilizer management package for dragon fruit cultivation in Bangladesh

An experiment was conducted at the Horticulture Research Centre, Regional Agricultural Research Station, Jamalpur during 2016-17 to develop a fertilizer management package for Dragon fruit cultivation in Bangladesh.The experimental site belongs to the Agro-Ecological Zone 8 (Young Brahmaputra and Jamuna Flood Plain) and 9 (Old Brahmaputra Flood Plain) at $24^{0}56^{/}11^{//}$ N latitude, $89^{0}55^{/}54^{//}$ E longitude and at an altitude of 16.46 m. BARI Dragon fruit-1 variety was used in the experiment. Two plants per pillar were transplanted in April, 2014 maintaining 2.0 x 2.0 m spacing. The experiment comprise of five treatments of the following doses of fertilizers: Package-1: Urea:100g/month, TSP: 100g/month, MoP: 100 g/month and 2kg Manure/month; Package-2: Urea: 50g/4months, TSP : 50g/4 months, MoP: 50g/4 months and 2kg manure/4 months; Package-3: Urea : 200g/2 months, TSP : 200g/2 months, MoP: 200g/2 months; Package-4: Urea: 200g/2 months, TSP: 200g /2 months, MoP: 200g /2 months and 5kg manure/4 months and Package-5: Urea: 100g/4 months, TSP: 100g/4 months, MOP: 50g/4 months and 15kg manure/year. The results revealed that there were significant differences in all the parameters under study except days to first flowering among the treatments as influenced by different fertilizer packages. The tallest plant (258.67 cm) was observed in T_1 treatment. The treatment T_1 exhibited the highest number of branches (64.67). The highest number of fruits per plant (9.67) was noted in T_1 treatment. The biggest fruit (322.53 g) was observed in the T_4 treatment. The longest fruit (12.21cm) was observed in treatment T_4. The maximum fruit breadth (7.74 cm) was obtained in treatment T_4. The highest TSS (10.67%) was recorded in T_1 treatment that was significantly similar to T_2 (10.27%) and T_4 (10.50%) treatments.The results depicted significant differences in terms of edible portion among the treatments. The maximum edible portion (75.16%) was observed inT_3 which was similarly followed by T_4 (74.58%). The minimum edible portion (70.99 %) was found in T_5. The highest fruit yield (2.80 kg per plant) was observed in treatment T_1 which was followed by T_4 treatment (2.26 kg/plant). On the other hand, the lowest fruit yield (1.24 kg/plant) was found in (T_3) treatment. The results revealed that application of fertilizers according to Package-1: Urea=100g/month, TSP=100g/month, MoP=100g/month and 2kg Manure @ once a month would be optimum for higher yield of dragon fruit in Bangladesh. This is the 1st year result. So, the experiment will be continued in the next year for confirmation of the result.

Development of a fertilizer management package for dragon fruit cultivation in Bangladesh

Performance of dragon fruit in response to various fertilizer was studied at the Horticulture Research Center, Regional Agricultural Research Station, Jessore. The study included five fertilizer management packages: P_1: urea 217 g/ month, TSP 500 g/month, MoP 200 g/month and 2 kg manure@ once a month, P_2: urea 110 g/ 4 months, TSP 250 g / 4 months, MoP 100 g/4 months and 2 kg manure @ every 4 months, P_3: urea 435 g/2 months, TSP 1 kg/2 months and MoP 400 g/2 months, P_4: urea 435 g/2 months, TSP: 1 kg/2 months, MoP 400 g/2 months and 5 kg manure @ every 4 months and P_5: urea 72 g/4 months, TSP 88 g /4 months, MoP 40 g /4 months and 20 kg manure/year. All the parameters under study varied significantly among the treatments except individual fruit weight. However, the treatment P_1 and P_4 produced the tallest plant (2.70 m) and the treatment P_2 produced the shortest plant (2.39 m). Number of fruits/pillar (4 plants) was observed maximum (21.67) in the treatment P_1 followed by the treatment P_3 (13.00) and minimum fruits was observed from the treatment P_5 (4.00). The longest fruit (8.50 cm) was obtained from the treatment P_4 which was followed by the treatment P_3 (7.72) and the smallest fruit was produced by the treatment P_2 (6.15 cm). The fruit diameter was noted the highest in P_3 (6.53 cm) and the lowest in P_5 (5.17 cm). The treatment P_3 produced the fruit with highest edible portion (70.68 %) followed by the treatment P_2

(69.21 %), while minimum edible portion was recorded in P_5 (42.13 %). The highest yield (8.16 t/ha) was manifested from the treatment P_1, which was followed by the treatment P_3 (7.71 t/ha) and on the other hand, the lowest yield was recorded in the treatment P_5 (1.73 t/ha). Considering yield, yield contributing characters the treatments P_1 and P_3 performed better compared to the other treatments. However, as it is the first year experiment, therefore it should be repeated in the next year for the confirmation of the result.

Effect of zinc as foliar spray on the growth and yield of sweet orange

The experiment was conducted at the research field of Regional Horticulture Research Station of Bangladesh Agricultural Research Institute (BARI), Narsingdi to develop a recommendation of foliar Zn application to rectify the deficiencies, which in turn improve the growth, nutritional status, fruiting and fruit quality of sweet orange. Four treatments were considered with different levels of Zn as T_1: 0.50 % $ZnSO_4$ solution, T_2: 0.75 $ZnSO_4$ solution, T_3: 1.00 % $ZnSO_4$ solution and T_4: (control). All other organic and inorganic fertilizers and manures was applied as blanket dose as per recommendation. All the parameters were significantly influenced by the treatments. The longest plant was recorded in T_3 (2.65 m). Maximum spread in North-South (2.30 m) and East-West (2.00 m) direction was recorded in T_3 and T_1 treatments, respectively. Maximum number of fruit per plant was recorded from T_3 (56.34). Individual fruit weight was noticed maximum from T_3 (167.23 g). Maximum TSS (%) was recorded from the treatment T_3 (8.84). From the one year study, it was observed that foliar spraying of higher dose of Zn may increase plant growth as well as yield and quality of sweet orange. The experiment should be continued for next years for further evaluation.

Maintenance of strawberry plantlets in the nursery bed and subsequent growth and development in the main field as influenced by tricho-compost and tricho-leachate

Effect of soil amendment through tricho-compost as soil application and tricho-leacheate as foliar spray alone or in combination were studied on the maintenance of plantlets in the nursery and their subsequent growth and development in the main filed during September 2015 to March 2016 and 2016-2017. BARI Strawberry-1 was used in this experiment. The study included the treatments were; T_1: Soil incorporated with tricho-compost T_2: Foliar application of tricho-leacheate, T_3: combined application of T_1+T_2, T_4: Control. Tricho-compsot was applied @ 4.5 t/ha as per treatment. Foliar application of Tricho-leacheate was done as per treatment combinations. The runner productions started from July, 2015 and 2016. Blanket doses with cowdung, urea, TSP, MoP, gypsum, zinc sulphate, Borax @ 20000, 175, 150, 100, 12 and 10 kg/ ha, respectively were applied in the field before planting. Tricho-compost (T_1) was applied in the bed before transplanting seedling. Trich-leacheate was applied at 15 days interval. The lowest sapling mortality (6.67 %) was recorded when soil treated with trichocompost and plants sprayed with tricho-leacheate (T_3) while, the highest plant mortality (16.67%) was recorded in control. Number of runner production per plant (3.81) was found maximum in the plants grown in soil fertilized with tricho-compost and foliar application of tricho-leacheate. Saplings planted in the beds treated with trichocompost @ 4.5 t/ha (T_1) produced flowers earlier compared to control. Earlier harvest was noted in soil incorporated with tricho-compost (T_1) whch was followed by foliar application of tricho-leachet (T_2). Saplings planted in control plot took longer period to flowering as well as harvesting. Harvest duration of plant treated with tricho compost and tricho leachate were longer as compared to control. The highest number of fruits per plant 26.78 (2016) and 39.33 (2017) was recorded in T_3. Maximum individual fruit weights of 23.29 g (2016) and 23.28 g (2017) were registered in T_3. The highest TSS content of 10.77 (2016-2017) was recorded in fruits harvested from the plants under soil fertilized with tricho- compost (T_1). The highest yield per plant 621.68 g (2016) and 837.50 g (2017) and yield per hectare 13.81 tons (2016) and 17.49 tons (2017) were obtained from the plants treated with the combination of tricho-compost and tricho-leacheate (T_3). Soil treated with tricho compost along with tricho leachate spraying (T_3) exhibited lower per cent of mortality and higher number of runner production earlier flowering and harvesting and superior yield.

Life cycle events of dragon fruit germplasm at Narsingdi region

Six dragon fruit germplasm namely; HU Nar-001, HU Nar-002, HU Nar-003, HU Nar-004, HU Nar-005 and HU Nar-006 were evaluated at the RHRS, Shibpur, Norsingdi. Maximum plant height (367.06 cm) was observed in the germplasm HU Nar-04 and minimum plant height (289.56 cm) was observed in HU Nar-03. First flower initiation happened in the last week of April, 2015 and the range of flash number was recorded within 6 to 8. Range of bud to flower setting was recorded from 15 to 18 days and flower to fruit setting was recorded from 6 to 7 days. Duration of fruit set to harvesting ranged from 19 to 21 days. Duration of anthesis ranged from 5 to 8 hours. Harvest duration varied from the last week of May to the middle of October at Norsingdi. The highest harvest duration was noted in HU Nar-006 (133), whereas minimum harvest duration was noted in HU Nar-005 (94). The highest length of flower was recorded in HU Nar-004 (31.00 cm). Average fruit weight ranged from143.27 to 340.23 g. The highest yield per pillar was manifested in HU Nar-004 (6.42 kg), whereas the lowest yield was manifested in HU Nar-005 (2.29 kg). Maximum edible Portion (77.72 %) and TSS (14.5%) were recorded in HU Nar-001. Considering morphological, floral, fruit characteristics and yield, the germplasm HU Nar-001, HU Nar-004 and HU Nar-006 resulted in superior performance over other germplasm.

Effect of bagging on yield and quality of mango in the hilly area

In response to bagging, a study was conducted at the existing eight years old mango orchard of BARI Aam-3 at the hill valley of Hill Agricultural Research Station, Raikhali in Rangamati Hill District. Seven types of bag were used in this study namely; brown paper bag (china origin), white paper bag (china origin), brown paper bag, cellophane paper bag, black polythene, transparent polythene and transparent polythene with open lower side. All types of bag were used on 15 March, when the fruits were of 35 days old. The least number of fruit drop (3.3%), insect infestation (nil), disease infection (10%), birds attack (nil), maximum individual fruit weight (241g) and self life (8 days) were noticed in brown paper bag (China origin). Maximum marketable mango (96.7%) as well as grade-1 mango (86.7%) was noted in brown paper bag (China origin). On the other hand, minimum number of marketable mango (60%) was noticed in control treatment, but minimum shelf life (2 days) was recorded in polythene bags. The result revealed that good quality mango was obtained using bagging technology. However, among all types of bag; brown paper bag (china origin) and white paper bag (china origin) had better performance, but mango bagged with brown paper bag (china origin) developed attractive color.

Effect of post-harvest pruning on maintaining tree size and quality yield of mango in the hilly area

Tree size, yield and quality of mango due to the effect of post harvest pruning was studied at the existing nine years old mango orchard of BARI Aam-3 at the Hill Agricultural Research Station, Raikhali, Rangamati Hill District. The study included 4 types of pruning at 10 (P_1), 20 (P_2), 30 (P_3) and 40 (P_4) cm from the shoot apex and a control (no pruning). Pruning of the plant was done just after harvesting mango. Maximum number of shoot (3.9) was developed from the plant, which was pruned 40 cm from the shoot apex. On the contrary, minimum shoot (2.5) was developed from P_1 (10 cm) treatment. Average number of fruits per plant (243) was registered the highest in P_5 (40 cm) treatment compared to the lowest (190) number of fruits in P_2 (10 cm) treatment. The heaviest individual fruit (232.3 g), maximum fruit length (9.1 cm), fruit breadth (6.1 cm), thickness (5.6 cm), edible portion (68.3%) and fruit yield (13.8 t/ha) were recorded in P_4 (30 cm) treatment, whereas the lightest individual fruit (178.3 g), minimum fruit length (8.6 cm), fruit breadth (5.9 cm) and thickness (5.3 cm) and yield (10.3 t/ha) were recorded in control (no pruning). The highest TSS (22.1%) was recorded in P_3 (20 cm) treatment as against the lowest (19.4%) TSS in P_2 (10 cm) treatment. On the basis of first year result, pruning seems better than control (no pruning) treatment. The experiment will be continued.

Effect of foliar application of boron and zinc on the yield and quality of mango (*mangifera indica* l.) cv. mallika

The study was carried out to determine the effects of foliar application of B and Zn on the yield and quality of mango (*Mangifera indica* L.) cv. Mallika at the RHRS, Chapainawabganj. The experiment was laid out in a Randomized Complete Block Design with three replications. The study included five treatment combinations; T_1: H_3BO_3 0.25% + $ZnSO_4$ 0.25%, T_2: H_3BO_3 0.50% + $ZnSO_4$ 0.50%, T_3: H_3BO_3 0.25% + $ZnSO_4$ 0.50%, T_4: H_3BO_3 0.50% + $ZnSO_4$ 0.25% ,T_5: Control treatment with distilled water spray . The foliar spray of all these treatments was performed just before flowering and at full bloom stage. The treatments differed significantly for their responses to growth, stone and other fruit characters. The highest terminal shoot length (25.5 cm) was recorded in $T_{2,}$ while the lowest shoot length (16 cm) was recorded from control (T_5) . The treatment T_2 gave maximum number of leaves (16). Results revealed that the application of micronutrients; ($H_3BO_{3,}$ $ZnSO_4$) significantly improved the quality of fruit than the control. Trees sprayed with H_3BO_3 0.50% + $ZnSO_4$ 0.50% (T_2) exhibited maximum average fruit weight (520 g), edible portion (78%), TSS (26.5%) and number of fruits per plant (210) and yield (109.2 kg) in comparison to rest of the treatments and control. Considering growth, yield and yield contributing characters and quality, spraing of H_3BO_3 0.50% + $ZnSO_4$ 0.50% resulted in superior result. As it was 2nd year observation, the study should be continued confirming the result.

Impact of salicylic acid on quality and shelf life of mango

Salicylic acid is recognized as a plant growth regulator that classified as a phenylpropanoid compound. The experiment was conducted at the RHRS, Chapai Nawabganj to improve the quality and shelf life of mango. The cultivar BARI Aam-3 and Mallika were used in the study. The mango fruits were dipped in aqueous solution of salicylic acid for 10 minutes then air dried. The treatments included: T_1: Aqueous solution of SA @ 1 mM/L, T_2: Aqueous solution of SA @ 2 mM/L, T_3: Aqueous solution of SA @ 3 mM/L, T_4: Aqueous solution of SA @ 4 mM/L, T_0: Control (water dipping). Among the treatments, salicylic acid at the concentration of 1mM/L performed the best for extending the shelf life and controlling anthracnose and stem-end rot diseases of mango. Maximum shelf life was attained in both the varieties BARI Aam-3 (8.6 days) and Mallika (10.8 days) treated with 1 mmol/l salicylic acid. The lowest incidence of anthracnose (10%, 30%) and no incidence of stem end rot (0%, 0%) were recorded in SA @ 1 mM/L in BARI Aam-3 and Mallika, respectively. Lower doses of salicylic acid like @ 1 mM/l or 2 mM/L suppressed anthracnose as well as stem-end rot and extended shelf life of mango in both the varieties of BARI Aam-3 and Mallika.

Performance of fruit bagging on different mango varieties at different locations

Performance of mango in response to fruit bagging was studied at the Regional Horticulture Research Station, BARI, Chapainawabganj and Mithapukur, Rangpur to improve fruit colour and reducing pesticide application. Mangoes are susceptible to different insect-pest and diseases. In this experiment seven BARI released and 1 commercial variety (Harivanga) were included. The fruits of each of the varieties were bagged 40 days after fruit set. Just prior to bagging one spay with the mixture of one insecticide i.e. Confidor @ 0.2 g/L and one fungicide i.e. Indofil M-45 @ 2 g/L. Three treatments were used viz., T_1: brown colour double layered paper bag, T_2: white color single layered bag and T_3: control (without bagging). Brown colour double layered paper bag changed fruit color to all the varieties. At both the locations, good quality, clean, disease and insect free fruits were harvested. These results indicate that fruit bagging can improve fruit quality through the reduction of disease and insect-pest attack and extending shelf life of mango. From the experiment results, it is concluded that fruit bagging technology is effective for getting quality mango fruits. It is advisable to use brown coloured paper bag for getting coloured fruits i.e. yellow color and white coloured paper bag for retaining the original fruit colour of each variety.

Bio-chemical analysis of different mango varieties after fruit bagging

An experiment was performed at the Regional Horticulture Research Station, BARI, Chapainawabganj and Bangladesh Council of Science and Industrial Research Laboratory to know the bio-chemical composition of each mango variety in response to fruit bagging. Four mango varieties including two popular BARI released varieties; BARI Aam-4 and BARI Aam-7 and two commercial varieties like Fazli and Ashwina. The analysis of bio-chemical analysis is being continued upon the harvesting of each variety. Last year, bio-chemical analysis of BARI Aam-3 was done. This year, bio-chemical analysis of BARI Aam-4 has been completed. Bagging mangoes showed extended shelf life (12 days) compare to that of control (6 days). Total soluble solids of bagged mango (23%) is slightly higher than that of non bagged (22%) mango. Bagged mango contained 90.45 mg/100 g of vit.-C compared to non bagged mango, which contained 79.37 mg/100 g of vit.-C. Bagged mango also contained higher amount of vitamin-A (beta carotene) (7403.04 ug/100 g) than that of non bagged (3404.34 ug/100 g) mango. Total sugar of bagged mango was higher than that of non bagged mango.

Optimization maturity indices of BARI released and commercial mango varieties

A study on optimizing maturity indices of some BARI released and commercial mango varieties mangoes was conducted at the Regional Horticulture Research Station, Chapainawabganj. Mango as a climacteric fruit is frequently harvested before full ripening. Maturity indices of BARI released and other commercial mango varieties were studied to reduce post-harvest losses and having optimum fruit quality. In addition, optimum date is important for the extension of shelf life. Twelve mango varieties; BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4, BARI Aam-6, BARI Aam-7, BARI Aam-8, Gopalbhog, Khirsapat, Langra Fazli and Ashwina were included in the study. Maturity indices indicates the optimum date of harvesting. BARI released varieties; BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4, BARI Aam-6, BARI Aam-7, BARI Aam-8 and other commercial varieties like Gopalbhog, Khirsapat, Langra, Fazli were harvested at 87, 102, 97, 117, 113, 117, 128, 85, 90, 96 and 104 days after fruit set, respectively. Harvesting started at 4th week of May from BARI Aam-1 and Gopalbhog variety and continued upto second week of July (BARI Aam-7). Minimum days to maturity were recorded from the commercial variety Gopalbhog (85 days) followed by BARI Aam-1 (87 Days) and the longest time to maturity (128) was taken by BARI Aam-8. For more precision, the experiment needs to be continued to determine the proper maturity indices.

Effect of different fertilizers on internal breakdown of mango

Internal breakdown of mango, BARI Aam-3 in response to the effects of different fertilizers was studied at the Regional Horticulture Research Station, Bangladesh Agricultural Research Institute, Chapai Nawabganj. The plants were fertilized with four treatments viz. T_1: Control (no fertilizer), T_2: 7 kg $(NH_4)_2SO_4$ + 2kg $ZnSO_4$,T_3: Recommended dose (Cow dung, urea, TSP, MoP, Gypsum, $ZnSO_4$ and Boric acid @ 50 kg/tree, 2 kg/tree, 1 kg/tree, 400 g/tree, 500 g/tree,100 g/tree and 50 g/tree) and T_4: 7 kg $(NH_4)_2SO_4$ + 5 kg gypsum, T_5: 9 kg $(NH_4)_2SO_4$ + ½ kg boric acid. Highly significant variations were noiticed in case of initial fruit setting on 15 March, where T_2 showed maximum (20.87 fruits / panicle) fruit setting and T_1 exhibited minimum (11.60 fruits/ panicle) fruit setting. Maximum number of fruits dropping occurred during the first 12 days and then the second highest number of fruit dropping occurred during the next 11 days (22th day). Finally, the treatment T_2 showed the highest number of fruit retention per panicle (0.93) compared to the lowest fruit retention in T_1 (0.43) at harvest (24.06.17). Maximum TSS was recorded in T_2 and minimum TSS was recorded in T_1 at all dates of harvest. TSS was comparatively low in ripe harvested mangoes in all the treatments than those of all other dates of harvest except 12.06.17. Shelf life ranged from 7.86 days to 9.76 days, where T_2 exhibited the longest shelf life (9.76 days) and the shortest shelf life was obtained from T_1 (7.86 days). The highest yield per plant (kg) was obtained from T_2 (103.93 kg/ plant) as against the lowest yield in T_1 (20.67 kg/ plant). Edible portion (73.38 %) was recorded the highest in T_2 and the lowest edible portion (46.40 %) was noted in T_1. Maximum β Carotene was recorded in T_2 (29.34 μg/g). The highest number of jelly seed free mangoes were recorded in T_2 and the highest number of jelly seed affected mango were recorded in T_4 at different stages of harvest. Plants treated with $(NH_4)_2SO_4$, 7 kg + $ZnSO_4$, 2 kg (T_2) exhibited 100% jelly seed free mangoes, when harvested during 12.06.2017 to 16.06.2017 (90-95 days) which was followed by mangoes harvested at all dates (95.24% at 96 days, 100% at 98 days and 95.24% at 100, 102 days). On the other hand, ripe harvested mangoes exhibited maximum jelly seed (slightly and fully developed) in T_1 treatment (Total 19.05%). Maximum spongy tissue affected mangoes were recorded in the treatment T_4 (14.29%), when mangoes were harvested at ripe stage.Except T_1 and T_4 all other treatments performed better. Considering internal breakdown (jelly seed and spongy tissue), edible portion, yield and all other parameters T_2 exhibited the best performance among the treatments. To avoid internal breakdown (jelly seed and spongy tissue) fruits should not be harvested at ripe stage from the tree. Hence it may be recommended that fruits should be harvested at 90-96 days from 1st fruit setting and delay harvest should be avoided.

Effects of types of pruning on the tree stature and yield of litchi

An experiment to investigate the effect of types of pruning on the tree stature and yield of litchi was conducted at the Fruit Research Station, Rajshahi. The experiment consisted of four types of pruning viz. P_1 : Light pruning, P_2 : Medium pruning, P_3 : Medium hard pruning and P_4 : Hard pruning. Hundred per cent plants against all types of pruning were survived. Light pruning (P_1) required minimum days to sprouting (7 days) of new shoots while hard pruning required maximum days (30). Light pruning (P_1) showed regularity in flowering which was 90, 65 and 70% in the consequetive years; 2015, 2016 and 2017, respectively, while medium pruning started flowering after two years of pruning but medium hard and hard pruning produced flowering after three years of pruning. In the third year of pruning, though all the plants started flowering but significantly the number of fruits/tree was found maximum in the plants receiving medium type of pruning. Litchi plants can survive against any type of pruning. Medium to hard pruning of plants had adverse effect on flowering and fruiting in the following and next two-three years.

Effects of fertilizer dose with split application and main season fruit thining on year round guava production

Year round guava production in response to the fertilizer dose with split applications and main-season fruit thinning was studied at the Fruit Research Station, Binodpur, Rajshahi. Four doses of fertilizer and its application installments; T_1 : Applying 100% fertilizer of recommended dose in two installments, T_2: Applying 100% fertilizer of recommended dose in three installments, T_3: Applying 200% fertilizer of recommended dose in two installments and T_4: 200% fertilizer of recommended dose in three installments and four levels of main-season fruit thinning: P_0: control (no fruit thinning) P_1: 25% fruit thinning P_2: 50% fruit thinning P_3: 75% fruit thinning were included in the study. Treatments showed highly significant variation regarding fruit yield considering both number and weight of fruits per tree and individual fruit weight. Higher level of fruit thinning decreased fruit yield in main season, but it increased fruit yield in the rest harvesting period. Again, 200% fertilizer application with three installments increased the fruit yield round the year. Significantly maximum weight of fruits/tree (16.04 kg) was recorded in T_4P_0 treatment in main season fruit harvesting period (June-August), while the lowest fruit weight per tree (3.49 kg) was noted in T_1P_3 treatment. But in the next two harvesting periods; September-November and December- January, maximum weight of fruits/tree was noted in T_4P_3 which was statistically at par to that of T_4P_2 and the lowest fruit weight per tree was recorded in T_1P_0 treatment. However the total average number of fruits per tree was recorded maximum in T_4P_2 (34.14 kg), which indicated that 200% fertilizer application at three installments combined with 50% main season fruit thinning increased fruit yield in the lean season guava production. Plant receiving 200% fertilizers of recommended dose in two or three installments and 50-75% main season fruit thinning of guava had significant influence on year round guava production.

Performance of top working in mango

An experiment was carried out at the ARS, Pahartali, Chittagong from March 2014 to April, 2017 to evaluate the performance of top working by veneer grafting in old mango tree. Four mango varieties mango varieties namely, BARI Aam-1, BARI Aam-3, BARI Aam-8 and Mallika were grafted and original mother plant (small seeded) was kept in control. Fifteen years old mango tree was selected for this study. Heading back or top working was done on 15th March at secondary branch level. Higher survival per cent of graft of BARI Aam-1, BARI Aam-3, BARI Aam-8 was recorded 80%, 70%, 60%, respectively. The per cent success was noted minimum (30%) in Mallika. The highest number of fruits (110) was recorded in BARI Aam-3 followed by original mother plant (small seeded) (105), BARI Aam-1 (75) and BARI Aam-8 (30). Minimum number of fruits was observed in Mallika (25). Maximum individual fruit weight was recorded in Mallika (455 g) followed by BARI Aam-8 (380 g). The highest TSS% was recorded in BARI Aam-1 (21) and the lowest TSS% was recorded in control plant (12). It is a good technique to convert the indigenous local mango germplasm into improved variety(ies) and also rejuvenate the old mango tree. A total of 96.5 kg mango was harvested from all the varieties contained in a 15 years old tree. This is second year observation. The study will be continued to confirm the result.

Project V: Disease Management

Survey of diseases of citrus

A survey program was conducted during 2016 in popular and widely citrus grown areas such as Balaier Char, Sherpur; Shibpur, Narsingdi; Raikhali, Rangamati and Horticulture fruit research field, Joydebpur to find out the incidence of various diseases of citrus. Scab, canker, die-back, sooty mold and gummosis disease were recorded regardless of citrus species. Among them, gummosis was more prevalence. Gummosis disease incidence was higher in lemon than Kamala and Malta and the highest incidence (70%) was recorded at Shibpur, Narsingdi. Sooty mold and die-back disease were found in lemon only. The incidence of sooty mold was 10% at Balaier Char, Sherpur and 20% at Shibpur, Narsingdi whereas the incidence of die-back was 10% in Joydebpur, 20% in Balaier Char, Sherpur and 30% in Shibpur, Narsingdi. Canker disease was recorded in Lemon, Kamala and Malta. However the disease incidence was lower (4-15%). Scab disease infestation was recorded in lemon only and it was 5% in Joydebpur, 8% in Balaier Char, Sherpur and 10% in Shibpur, Narsingdi.

Collection and identification of straw berry diseases

A survey was conducted in fruit research field of Horticulture Research Centre, BARI, Gazipur during 2016-17 to know the disease incidence and severity of strawberry. A structural questionnaire was designed to capture information on agronomic practices, source of planting materials, management practices and economic losses caused by the diseases. Disease samples were collected at different growth stage of straw berry to identify the diseases. Disease infected fruits, leaves, runner and stem were collected and cultured on potato dextrose agar media. *Fusarium* sp., *Colletotrichum* sp., *Aspergillus* sp., *Penicillium* sp. and *Alternaria* sp. were identified from leaves and fruits. *Colletotrichum* sp. and *Fusarium* sp. were recorded in infected runner and fruits. Parasitic nematodes were recorded in roots and rhizosphere soil samples.

Management of gummosis disease of citrus

The experiment was conducted with Colombo lebu at daptergaon, Shibpur, Norsingdi during December, 2016 for management of gummosis disease of citrus. Experimental design was laid out randomized complete block with three replications. Eight to ten years old, 15 disease infected plants were selected for the experiment and one plant was considered as one replication. Treatments were (i) Tricho-compost + Bordeaux paste [$Ca(OH)_2$:$CuSO_4$:H_2O=1:1:10]; (ii) Tricho-compost + Bordeaux mixture [$Ca(OH)_2$:$CuSO_4$:H_2O=1:1:100]; (iii) Tricho-compost +Secure; (iv) Tricho-compost + Coalter (Phenol, Polycyclic aromatic hydrocarbons); and (v) control. Tricho-compost @ 1.5 kg/plant was applied in root zone of the plant to control soil borne pathogens. Length and diameter of lesion was measured after each application of treatments. Lesion size remarkable reduced after thrice application of Coalter. The length and diameter reduction were 78.75 and 81.00%, respectively in combination with Tricho-compost and Coalter. While it reduced about 34.96 and 55.45%, respectively in Tricho-compost and Bordeaux paste.

Project VI: Insect Pest Management

Efficacy of different types of bags for management of mango fruit fly *Bactrocera dorsalis* attacking mango

A research work on efficacy of different types of baggs for management of mango fruit fly *bactrocera dorsalis* attacking mango was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi during January-June 2017. Eight different control approach viz bagging by polythen bag, bagging by butter paper bag, bagging by brown paper bag, bagging by mosquito net, bagging by mosquito net (Bag banded by Bokrom), bagging by China brown paper bag, bagging by China white paper bag and untreated control against mango fruit fly. The per cent infestation was the highest (58.66 %) in the untreated control. The least zero per cent infestation was found in plant treated by all types of bagging except bagging by mosquito net which caused 12.00 % infestation. To control the mango fruit fly all types of bagging showed the best result with 100 % infestation reduction over control except bagging by mosquito net (79.54 % reduction). The highest gross margin was noticed in Bagging by polythen bag (778860) while the lowest in untreated control (661000). The highest MBCR (2.29) was found in bagging by polythen bag and the lowest (0.78) in bagging by mosquito net.

Development of management approach against mango fruit fly, *Bactrocera dorsalis*

The experiment was conducted at farmers' fields of three locations such as Gazipur, Rajshahi and Chapainawabgonj during February to July 2016 to find out the best control measures for managing mango fruit fly. Total seven treatments such as T_1: Setting of methyl eugenol pheromone trap at six weeks before mango harvest) ,T_2: Protein hydrolysate bait trap at six weeks before mango harvest, T_3: Bagging by cloth bag at six weeks before mango harvest, T_4: Bagging by Polythin bag at six weeks before mango harvest, T_5: Foliar spray of Shobicron 425EC @ 1.5ml/L of water, T_6: Bagging by double layer brown paper bag at six weeks before mango harvest and T_7: Control were evaluated against mango fruit fly following RCB design with three replications. Results indicated that bagging of mango with double layer brown paper bags reduced 100% fruit fly infestation irrespective of location followed by bagging with polythene bag (90.09%) and cloth bags (89.75%). But protein hydrolysate bait trap provided the highest marginal benefit cost ratio (2.94) followed by methyl eugenol pheromone trap (2.13).

Survey, collection and identification of different pollinators of mango

A research work on the pollinator of mango was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi during February - March 2017 to know about the pollinator visited the mango orchard during flowering stage. The survey of insect species visiting mango flowers indicated that the highest number of species were from order Diptera (flies), 4, then Hymenoptera (ants, bees, wasp), 1. The insect population (number/100 panicle) was the highest 33.54 of Syrphid fly, in decreasing order of population were Ant (11.08), House fly (8.77), Blowfly (5.08) and Flower fly (2.23). On the other hand the five years averaged population was the highest 29.63 of Syrphid fly in decreasing order of population were Ant (10.95), House fly (8.56), Blow fly 4.67 and flower fly (2.33). The Syrphid fly was the most efficient pollinator due to its frequent appearance during flowering period. The highest number of insects were observed as a pollinator or visitor at the first half of the day (8 am to 11 am). No fruits were observed in completely bagged panicle (without pollination).

Survey, collection and identification of different pollinators of litchi

A research work on the pollinator of litchi was conducted at Fruit Research Station, Binodpur, Rajshahi during February-March, 2017 to know about the pollinator visited the litchi orchard during flowering stage. Five types of insects were recorded as a pollinator or visitor on litchi flower during flowering period. The survey of insect species visiting litchi flowers indicated that the highest number of species were from order Diptera (flies), 4, then Hymenoptera (ants, bees, wasp), 1. In BARI Litchu-1 the insect population (number/panicle) was the highest 1.23 of Syrphid fly in decreasing order of population were Honey bee (1.12), Flower fly (0.81), Blow fly (0.52) and House fly (0.36). In Bombai litchi the highest 2.01 of Honey bee in decreasing order of Flower fly (0.71), Srphid fly (0.63), Blow fly (0.20) and House fly (0.08). In Dinajpuri litchi the highest 2.27 of Honey bee in decreasing order of Syrphid fly (0.54), Flower fly (0.43), Blow fly (0.18) and House fly (0.09). The highest number of insect was observed as a pollinators/visitor at the first half of the day.

Susceptibility of different varieties of litchi to litchi mite (*Aceria litchi* Keifer)

An experiment on suceptibility of different varieties of litchi to litchi mite (*aceria litchi* keifer) was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi duuring 2016-17. Nine varieties/cultivars of litchi viz Bombai, BARI Litchu-1, China-3, Bedena, Dinajpuri, Mojaffarpuri, Green, Madrajee and BAU litchi-1 were tested against the incidence of litchi mite (*Aceria litchi*) and its extent of damage to litchi leaves and inflorescence. Among the tested varieties almost all the varieties/cultivars were susceptible to litchi mite. The highest infestation of 17.56% leaves recorded in Bombai litchi which was identical to Green, BAU litchi-1, BARI Litchu-1, Bedena, China-3 and followed by Mojaffarpuri and the lowest 7.56% infestation found in Dinajpuri.

Efficacy of different control measures against litchi mite (*Aceria litchi* Keifer)

The experiment was conducted at Fruit research station, Binodpur, Rajshahi duuring 2016-17 to know the effectiveness of different management practice for controlling litchi mite. Five treatments viz Pruning of infested foliage + Spraying of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5 ml /l of water), Pruning of infested foliage + Spraying of wettable Sulphur (Thiovit 80 WP @ 2 g/l of water), Pruning of infested foliage + Spraying of Dimethoate 40 EC (Tafgor 40 EC @ 2 ml/l of water), Pruning of infested foliage and Untreated control. Pruning was done two times first on June after harvesting of fruit and second in August and miticides were sprayed only one time before flower open. The lowest leaf infestation (3.65 %) was observed from Pruning of infested foliage + spraying of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5ml /liter of water) with 89.11% infestation reduction over control which is statistically different from other treatments and the highest leaf infestation (33.53 %) was observed from untreated control. In case of per cent infested inflorescence the lowest infested inflorescence (2.25 %) was also observed from Pruning of infested foliage + Spraying of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5 ml /l of water) while the highest infested inflorescence was observed from untreated control (9.67 %) which differed statistically from other treatments. The number of fruits was maximum (920000/ha) in Pruning of infested foliage + Spraying of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5 ml /l of water) while the lowest was in untreated control (506000/ha). The highest gross margin (1869560) was also noticed in Pruning of infested foliage + Spraying of Abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5 ml /l of water) against untreated control. The highest MBCR (5.20) was found in Pruning of infested foliage + Spraying of wettable Sulphur (Thiovit 80 WP @ 2 g/l of water. Pruning of mite infested leaf and inflorescence as well as spraying of Abamectin might be promising in controlling litchi mite.

Efficacy of different types of bagging for management of oriental fruit fly (*Bactrocera dorsalis)* attacking guava

A research work on efficacy of different types of bagging for management of oriental fruit fly (*bactrocera dorsalis)* attacking guava was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi during January-August 2016. Five different control approach viz bagging by polythene bag, bagging by butter paper bag, bagging by brown paper bag and bagging by mosquito net against guava fruit fly was included in this experiment. The highest per cent infestation (95.66%) was recorded in untreated control while the least zero percent infestation was found in the plant treated by all type of bagging except bagging by mosquito net which caused 49.33% infestation. All type of bagging against controling guava fruit fly showed the best result with 100% infestation reduction over control except bagging by mosquito net (48.43% reduction). The highest gross margin (1269600) was noticed in bagging by polyethene bags which followed by bagging with butter paper bags and bagging with mosquito net. On the other hand the lowest gross margin (283500) was observed in untreated control.

The highest MBCR (4.56) was observed in Bagging by perforated polythene bag while the lowest (0.53) was in Bagging by mosquito net.

Survey and documentation of different insect pollinators/visitors in different fruit crops during flowering period

The present study deals with the pollinator of insect on selected six fruit crops viz wax jambu, wood apple, longan, pummelo, phalsa and ber. In wax jambu the insect population was the highest 4.67 of Honey bee, in decreasing order of population were Flower fly (3.00) and Syrphid fly (1.00). In wood apple the insect population was the highest 4.16 of Honey bee in decreasing order of population were Flower fly (2.00) and Syrphid fly (1.83). In longan the insect population was the highest 4.33 of Blow fly in decreasing order of population were Flower fly (4.00), Honey bee (3.00), House fly (2.33) and Syrphid fly (0.83). In pummelo (Citrus) the insect population was the highest 2.17 of Bumble bee in decreasing order of Honey bee (0.83) and Syrphid fly (0.50). In phalsa the insect population was the highest 1.33 of unknown insect in decreasing order of population were Flower fly (1.17), Honey bee (0.50), and Bumble bee (0.17). In Ber the insect population was the highest 3.00 of Wasp in decreasing order of population were Honey bee (1.67), Flower fly (0.67), Blow fly (0.50) and House fly (0.33). Three to five types of pollinators/visitors were found from six types of fruit crop.

Survey and documentation of major pests of citrus

The survey was carried out in Gazipur, Narsingdi, Jamalpur, Jaintapur, Akbarpur,Khagrachari and Panchagorh areas of Bangladesh in Lemon, Lime, Pumello, Sweet orange, Mandarin and Jara lebu (citron) orchards during August 2016-May 2017 to findout the incidence and pest status of different citrus insect pests. Results showed that the infestation of leafminer was 25.50%, flower thrips 12.00% and mite 21.50% and possessed as major pest status in every locations. Psyllid bug was appeared as a serious threat to citrus crops especially in Jaintiapur and Khagrachari. Again the incidence of Leaf eating weevil (15.00%) and fruit sucking moth (22%) were found at Jamalpur and Khagrachari, respectively. So, from the results, it could be concluded that Leaf miner, flower thrips, leaf eating weevil, fruit sucking moth and mite were found as serious pest of citrus and proper management should be taken against these insect pests.

Development of management strategy (ies) for citrus flat mite infestation in jara lemon

The experiment was conducted at farmer's orchards at Shibpur upazila under Norsingdi district with the supervision of Regional Horticultural Research station, Bangladesh Agricultural Research Institute, shibpur, Norsingdi during February to June 2016 to findout the best control measures for managing flat mite. . Total eight treatments viz, T_1 : Clean cultivation (cleaning of debris, dead branches, etc. just after harvest), T_2 : Abamectin (Vertimec 1.8 EC) @ 1.2 ml/L water 3 times (at before flowering, after completion of fruit setting and at marble size), T_3 : Sulphur powder (McVit 80DF) @ 2 g/L water 3 times (at before flowering, after completion of fruit setting and at marble size), T_4 : Azadirachtin (Bioneem plus 1 EC) @ 1 ml/litre of water 3 times (at before flowering, after completion of fruit setting and at marble size), T_5 : T_1+ Alternate spraying of Vertimec 1.8 EC @1.2 ml/L and McVit 80 DF@ 2 g/L for 2- times at before flowering and after completion of fruit setting, T_6 : T_1 + Alternate spraying of Vertimec 1.8 EC and Azadirachtin (Bioneem plus 1 EC) @ 1.2 ml/litre of water for 2- times at before flowering and after completion of fruit setting and T_7 : Untreated control were evaluated against flat mite following RCB design with three replications. Results showed that T_5 (Clean cultivation + Alternate spraying of Abamectin (Vertimec 1.8 EC) @ 1.2ml /L and Sulphur powder (McVit 80 DF) @ 2 g/L for 2- times at before flowering and after completion of fruit setting) treated plants showed best performance in reducing flat mite infestation and increasing marketable yield. But T_4 Azadirachtin (Bioneem plus 1 EC) @ 1 ml/litre of water 3 times (at before flowering, after completion of fruit setting and at marble size) treated plants showed the highest marginal benefit cost ratio. Almost similar results were found in last year. So, this finding may be disseminated among farmers as a suitable and effective technology against flat mite management.

Project VII: Soil and Water Management

Effect of manganese, zinc and copper addition on the yield and quality of sweet orange

The experiment was conducted on sweet orange (BARI Malta-1) in HRC, BARI Gazipur during 2015 and 2016 to determine the optimum rate of Mn, Zn and Cu for quality sweet orange production and to develop a recommendation of foliar nutrients application to rectify the deficiencies which in turn improve the growth, nutritional status, fruiting and fruit quality of sweet orange. The study was undertaken followed by RCB design with 3 replications. Eleven treatments were considered with different levels of Mn, Zn and Cu as T_1 : $Mn_0Zn_{0.5}Cu_{0.4}$; T_2 : $Mn_{0.2}Zn_{0.5}Cu_{0.4}$; T_3 : $Mn_{0.3}Zn_{0.5}Cu_{0.4}$; T_4 : $Mn_{0.4}Zn_{0.5}Cu_{0.4}$; T_5 : $Mn_{0.3}Zn_0Cu_{0.4}$; T_6 : $Mn_{0.3}Zn_{0.2}Cu_{0.4}$; T_7 : $Mn_{0.3}Zn_{0.8}Cu_{0.4}$; T_8 : $Mn_{0.3}Zn_{0.5}Cu_0$; T_9 : $Mn_{0.3}Zn_{0.5}Cu_{0.3}$; T_{10}: $Mn_{0.3}Zn_{0.5}Cu_{0.5}$; T_{11}: Native fertility (control). From two years study it was observed that higher dose of Mn ($Mn_{0.4}$) and optimum doses of Zn ($Zn_{0.5}$) and Cu ($Cu_{0.4}$) may increase plant growth, number of fruit/plant (21.9 and 87.3) individual fruit weight (117.5 and 121.0 g) as well as fruit size and TSS percentage (8.9 and 10.6 %) of sweet orange.

Response of strawberry to boron and zinc fertilization

An experiment was conducted on strawberry (BARI Strawberry-3) at the research field of Horticulture Research Centre, BARI, Gazipur during rabi season of 2016-17 to evaluate the response of strawberry to B and Zn micronutrients and also to find out the optimum dose of boron and zinc for maximizing flower yield of strawberry. Sixteen treatments comprising four levels of B (0, 1, 2 and 3 kg/ha) and four levels of Zn (0, 2, 3 and 4 kg ha^{-1}) along with blanket dose of $N_{115}P_{40}K_{110}S_{25}$ kg/ha were used in the trial. Application of B and Zn and their combination had a profound effect on fruit characters and fruit yield of strawberry. Boron-Zinc integration was appeared to be more responsive than their single application. Number of fruit, length and diameter of fruit, individual fruit weight and yield of fruits were greatly influenced by the application of higher doses of boron-zinc combination and further increase of B and Zn suppressed the fruit production. The maximum number of fruit (12.45/plant), longest fruit length (4.72 cm), highest diameter of fruit (3.70 cm), individual fruit weight (18.54 g) and the highest fruit yield (9.23 t/ha) were recorded with combined application of $B_{2.0}Zn_{3.0}$ kg/ha. The yield of fruits increases due to $B_{2.0}Zn_{3.0}$ kg/ha was 5.95 t/ha which was 181% over control (without B and Zn)

Project VIII: Post Harvest Management

Effect of novel beeswax and coconut oil edible coating on postharvest quality of lemon

An experiment was conducted at the Postharvest Technology Laboratory of HRC, BARI to assess the influence of beeswax, coconut oil coating and modified atmospheric packaging (MAP) on postharvest storage quality of seedless lemon (*Citrus limon*). Lemons were harvested from one of the progressive farmer's field of Jamalpur district based on maturity, uniformity of size and absence of physical damage. Sorted and graded lemons were washed; fruit surface water was removed and then surface coated using three types of coating materials such as 100% coconut oil; beeswax-coconut oil mixture with ratio 90:10 and beeswax-coconut oil mixture maintaining ratio 80:20. After coating, lemons were kept in MAP or crates and stored at ambient condition (22±2°C and 50±5% RH). Data on weight loss, respiration rate, ethylene production rate, firmness, shrinkage, yellowing, decay incidence, TSS, P^H, ascorbic acid were collected and also organoleptic quality was analyzed periodically during storage. The results revealed that beeswax-coconut oil coating had immense effect on retaining green colour, reducing respiration rate, ethylene production, weight loss, shriveling and preserving firmness of lemon throughout the whole storage period. Thus, the shelf life of green seedless lemon could be extended up to 18 days using surface coating with beeswax-coconut oil mixture and MA packaging at ambient storage condition maintaining better quality.

Effect of edible coating on postharvest quality of ber

An experiment was conducted at the Postharvest Technology Laboratory of HRC, BARI to assess the influence of Aloe vera gel and chitosan coating on postharvest storage quality of Ber (*Zizyphus* *mauritiana* Lam.). Bers were harvested from fruit farm of HRC based on maturity, uniformity of size and absence of physical damage. Sorted ber was coated either with chitosan (1.5% and 2% solution) or Aloe vera (AV) gel. Surface coating was air dried using high speed fan, kept into paper cartoon and stored at ambient condition (25 ± 1°C and 45 ± 5% RH). The success of coating in retaining postharvest quality of ber was evaluated by determining respiration rate, ethylene production, firmness, weight loss, external colour change, ß-carotene content, ascorbic acid content, TSS, P^H, fungal decay and sensory quality. AV gel or chitosan coating reduced respiration rate, weight loss, decay and preserved colours, firmness, ascorbic acid content and other quality parameters thus delaying the progress of fruit decay due to senescence. Initial TSS, total sugar, titratable acidity and ascorbic acid content was 15.8%, 9%, 0.2% and 92.3 mg/100g respectively. At 6^{th} day of storage, ascorbic acid and acidity decreased slightly, while total sugar and TSS increased. ß-Carotene content in fresh ber was 28.15 mg/kg. At 6^{th} day of storage ß-Carotene content in all treatments was increased significantly. The highest amount of ß-Carotene (47.55 mg/kg) was found in 2% chitosan coated fruits at 6^{th} day that was statistically similar with AV gel treated bers. AV gel coated ber was still crancy and crispy while uncoated ber was soft, shrinked and dark brown coloured at 6^{th} day of storage.

Project IX: Socio-Economic Studies

Study on the status of fruit cultivation in south and south-western region in Bangladesh

The study to learn about the existing status of fruit cultivation and its comparative status as against other perennial trees was conducted in Bhola and Khulna district. A total of 33 and 17 fruit trees were identified having surveyed randomly selected 30 and 32 farmers in Bhola and Khulna districts, respectively. Inclusive all types of trees, the numbers of trees were 48 in Bhola and 20 in Khulna. Major trees were areca nut, coconut, raintree, mango, jackfruit, mahogany, guava, ber, velvet apple, chambul in Bhola and ber, mango, coconut, areca nut, guava in Khulna. In both Bhola and Khulna, in terms of type and number, the fruit trees were much higher than other non-fruit trees. In terms of type, fruit and non-fruit tree ratio was 2.2 and 5.67, and in terms of number, fruit and non-fruit tree ratio was 3.95 and 53.53 in Bhola and Khulna, respectively. Total numbers of trees owned by the respondent farmers were found 12399 and 5935 in Bhola and Khulna respectively. It was found in the study that average total land owned by the respondent farmers was 95.3 decimals in Bhola and 258.51 decimals in Khulna, in which cultivated land was 41 decimals (43.04% of total land area) and 116.5 decimals (45.07%) followed by garden 17.1 decimals (17.95%) and 48.84 decimals (18.89%) in Bhola and Khulna districts respectively. Homestead area is 15.9 decimals (16.69%) and 25.92 decimals (10.03%), pond 13.7 decimals (14.38%) and 40.69 decimals (15.74%) in Bhola and Khulna districts respectively. In Bhola, tree per decimal in garden was 15.51 and in homestead it was 4.95, which is very much dense. In Khulna, tree per decimal in garden and homestead were 1.97 and 1.63 respectively. Hence, it is observed that in all categories of land, the density of the trees in Bhola district is much higher than that of Khulna district. In Bhola district farmers resorted to fertilizer application was 63.33%, irrigation 73.33%, pesticide application 76.67%, pruning 96.67%, grading 80%, planning to grow tree in future 86.67%. In Khulna district, farmers resorted to fertilizer application was 53.13%, irrigation 46.88%, pesticide application 78.13%, pruning 71.88%, grading 50%, planning to grow tree in future 78.13%. In Bhola, among the fruit trees, farmers received highest cash income excluding own consumption from areca nut of Tk 120850/- (24.58% share of total cash income) followed by coconut Tk 54550/- (11.1% share), jackfruit Tk 31000/- (11.1% share), mango Tk 29950/- (6.09% share), lemon 7720/- (1.57% share). Among all the trees, highest cash income was earned from raintree of Tk 154000/- (31.33% share). In Khulna, among all the trees, farmers received highest cash income from ber of Tk 1174500/- (75.61% share) followed by mango Tk 120000/- (7.72%), guava Tk 110000/- (7.08%), coconut Tk 84000/- (5.41%), areca nut Tk 50900/- (3.28%). Farmers' yearly total cash income in Bhola and Khulna were 491600/- and 1553400/- respectively, indicating that farmers got higher production in Khulna than that of in Bhola though the number of trees in Bhola was much higher than that of in Khulna, which indicates that proper spacing and planning is very important to get increased return. It can be easily inferred that the over density of trees, which was found in Bhola, is rather hindrance of getting optimum output from the trees. It was also found in the study that no new types of trees would be grown in future both in Bhola and Khulna. Respondent farmers expressed the need of training on control of disease and insect, fertilizer management, improved cultivation method etc for higher yield. Therefore, training on the matters stated above along with proper spacing of trees is very much essential for the farmers. In Barisal region, it is their convention to grow trees with high density. Therefore, motivational activities should be taken to come out from the convention of growing over density of trees in Barisal region and a plan of ideal tree gardens in homestead of fruit trees combined with other trees is suggested with the introduction of some trees not exist in that region.

Project XI: Urban Horticulture

Standardization of growth media for roof gardening of mango

An experiment to standardize the growth media in term of plant growth, fruit retention as well as yield and quality of mango c.v. BARI Aam-3 for roof top gardening was performed at the Fruit Research Farm of Horticulture Research Centre, BARI, Gazipur during 2016-17. There were 18 treatments i.e. T_1: 50% Soil +50% Cowdung, T_2 :50% Soil + 25 % Sand + 25% Cowdung, T_3 : 50% Soil +25 % Cocodust + 25% Vermicompost, T_4:50% Soil + 25 % Cocodust+25% Tricocompost, T_5:50% Soil + 25 % Sawdust + 25% Vermicompost, T_6 :50% Soil + 25 % Sawdust + 25% Tricocompost, T_7 :50% Soil + 25 % Burn Rice Husk + 25% Vermicompost, T_8:50% Soil + 25 % Burn Rice Husk+25% Tricocompost, T_9:50% Soil + 25 % Sand+ 25% Vermicompost, T_{10} :50% Soil + 25 % Sand +25% Tricocompost, T_{11} :50% Soil+ 50% Vermicompost, T_{12}:50% Soil + 50% Tricocompost, T_{13}:50% Soil +50% Mustard Oil Cake, T_{14}:50% Soil + 25% Mustard Oil Cake+25% Sand, T_{15}:50% Soil + 50% Cocodust, T_{16} :50% Soil + 50% Sawdust, T_{17} :50% Soil+ 50% Burn Rice Husk, T_{18}:100% Soil. Maximum plant height was observed in the medium comprising 50% Soil +50% Cowdung (3.37 m) and minimum plant height was noted in the medium of 50% Soil +50% Mustard Oil Cake (1.30 m). Maximum tree volume was recorded in T_3 (2.70 m^3). Number of fruit set per panicle (25.33) was attained maximum in T_2 (50% Soil + 25 % Sand + 25% Cowdung) and minimum (9.57) was in T_{17} (50% Soil+ 50% Burn Rice Husk). The biggest fruit in terms of weight was recorded in T_2 (50% Soil + 25 % Sand + 25% Cowdung) (216.00g) followed by T_7 and T_9 (184.60g and 186.00g respectively). The smallest fruit was obtained from T_{10} (50% Soil + 25 % Sand +25% Tricocompost) (148.07g). TSS (%) ranged from 26.50% to 20.67%, where T_9 had maximum (26.50%) TSS (%) and the lowest (20.67 %) TSS content was noted in T_1 (50% Soil +50% Cowdung). Yield per plant (4.67kg) was recorded the highest in T_4, followed by T_2 (3.83kg) and T_7 (4.30kg), where the lowest yield was obtained from T_{10} (50% Soil + 25 % Sand +25% Tricocompost) (2.17kg/plant).The highest milly bug infestation was noted in T_3 (10.20%) and the lowest in T_9 (1%). Fruit cracking was noticed the highest in T_{15} (15.30%) and the lowest in T_2 (3.8%). The treatments T_4 and T_{12} were found totally free from any type of infestation, infection and physiological disorders.

Project XII: Adaptive Trial

Field validation trial of ICM technologies during 2017 at Mujibnagar (Meherpur) and Chuadanga for reducing flower and fruit dropping in mango

Large-scale farm level field validation trial as well as small scale up scaling of developed ICM technologies has been done at the farmers' field of the two mango growing districts of Bangladesh, viz. Chuadanga and Meherpur during the mango growing season 2017 under KGF funded project "Sustainable Management of Flower and Fruit Dropping of Mango". Under ICM packages, promising result for the variety Bombai viz. 15.56% increased yield was recorded at Chuadanga sadar this year. In case of the variety Himsagar satisfactory results viz. 14.29% and 15.13% increased yield were recorded at Chuadanga sadar and Mujibnagar, Meherpur, respectively. Similarly, in case of the variety

Langra satisfactory results viz. 16.22% and 15.43% increased yield were recorded at Chuadanga sadar and Mujibnagar, Meherpur, respectively. This year the average number of fruits per plant under ICM packages for the variety Bombai was also recorded higher than that of Non-ICM packages in the Chuadanga district and it was recorded 577.8 number of fruits per plant under ICM packages, while it was recorded 500 number of fruits per plant under Non-ICM packages. In case of the variety Himsagar, the average number of fruits per plant under ICM packages was also recorded higher than that of Non-ICM packages in the Chuadanga and Meherpur (Mujibnagar) district and it was recorded 813.2 number of fruits per plant at Chuadanga and 1041.7 number of fruits per plant at Mujibnagar, Meherpur under ICM packages, while it was recorded 711.5 number of fruits per plant at Chuadanga and 904.8 number of fruits per plant at Mujibnagar, Meherpur under Non-ICM packages. Similarly in case of the variety Langra, the average number of fruits per plant under ICM packages was also recorded higher than that of Non-ICM packages in the Chuadanga and Meherpur (Mujibnagar) district and it was recorded 755.4 number of fruits per plant at Chuadanga and 754.7 number of fruits per plant at Mujibnagar, Meherpur under ICM packages, while it was recorded 650 number of fruits per plant at Chuadanga and 653.8 number of fruits per plant at Mujibnagar, Meherpur under Non-ICM packages.

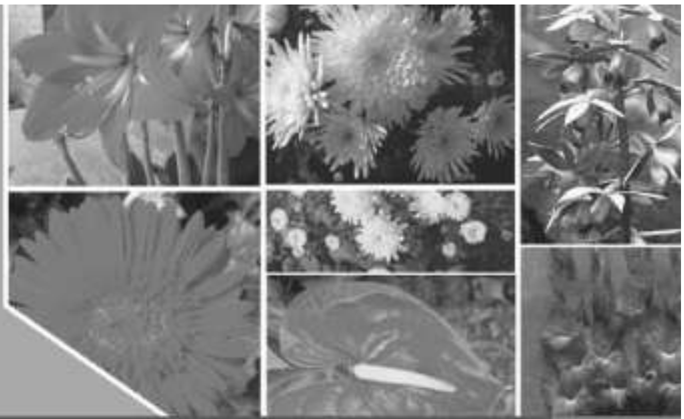
Validation trial of tissue cultured plantlets of malta under field condition

An experiment on the validation of tissue cultured plantlets of malta under field condition at the hill valley of Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District was performed. The grafted saplings of BARI Malta-1 and tissue cultured plantlets were planted in August 2011 maintaining a distance of 4 × 4 m. The tissue cultured malta produced thorn on its whole branches, whereas grafted malta was totally thornless. Average plant height (280 cm), base girth (46 cm), number of branch/plant (23.7), height of main trunk (48.7 cm), canopy (316.6 x 343.3 cm) and fruits per plant (193.7) were higher in grafted plant. Tissue cultured malta produced fruits, when it was five years old, but grafted malta produced fruits after three years planting. Average number of fruits per plant was 41.3 in tissue cultured malta,on the other hand the grafted malta had 193.7 fruits. From the two years results, no decision can be made comparing the two types of plants. However, this experiment should be continued for having the concrete result.

Field validation of ICM technologies in reducing flower and fruit dropping of mango at farmers field in Rajshahi and Natore regions of BANGLADESH

Large-scale farm level field validation trial as well as small scale up scaling of developed ICM technologies was carried out at the farmers' field of the two major mango growing districts of Bangladesh, viz. Rajshahi and Natore under KGF funded project "Sustainable Management of Flower and Fruit Dropping of Mango". Integrated Crop Management (ICM) packages included Recommended fertilizer doses, application in 3 installments at September, March and April + 2 sprays with 2% urea solution spraying at pea and marble stage of fruit + 4 irrigations at flowering, just after fruit set and at 15 days interval of fruit set (if necessary) + 2 sprays with fungicide and insecticide simultaneously (Indofil M-45 @ 2g//l + Confidor @ 0.2 g/l). The whole Cowdung, TSP, Zinc sulphate, Gypsum, Boric acid and half of the urea and MoP was applied at the month of mid September, one fourth of urea and MoP was applied in the last week of March and the rest one fourth was applied within the last week of April to 1st week of May. In case of Non-ICM, famers own management practices were included. The promising results was found under ICM packages. It reduced fruit dropping at 8.1% and 7.2% over Non-ICM packages in Rajshahi and Natore, respectively. It also increased 31.3% and 29.9% yield in the above mentioned two districts. The higher number of fruits per plant (390, 365) was recorded in ICM packages. The ICM packages also produced bigger fruit (280, 275 g) than that of Non-ICM packages in Rajshahi and Natore districts, respectively.

8 FLOWER CROPS



Evaluation of chrysanthemum genotypes

Thirty chrysanthemum genotypes with BARI Chrysanthemum-2 as check variety were evaluated at the Floriculture field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during winter season of 2016-17. Significant variation was observed among the genotypes in respect of plant height (35.0-65.0 cm), number of flowers per plant (15.0-70.0), diameter of flower (2.6-8.8 cm), stalk length (4.2-12.5 cm) and vase life of flowers (5.0-13.0 days). Among the genotypes, CM-004 and CM-022 were found superior for cut flower production as well as CM-015, CM-018, CM-019 and CM-021 for pot culture.

Evaluation of gerbera genotypes

Twenty nine genotypes of gerbera with BARI Gerbera-1 were evaluated at the Floriculture field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during winter season of 2016-17 that showed wide range of variation for all quantitative and qualitative characters under study. Based on colour, flower number, flower size and vase life, the genotypes GJ-013, GJ-023, GJ-024 and GJ-028 were identified as promising genotypes.

Collection, evaluation and maintenance of dahlia genotypes

Twenty genotypes of dahlia were evaluated at the Floriculture Field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during winter season of 2016-17. Marked variation on different parameters was observed among the genotypes under study. Considering attractive colour, flower number and maximum durability of flower on the plant, DV-002, DV-007 and DV-010 may be recommended for lawn.

Performance study of gladiolus genotypes

A study was conducted at Floriculture Field, Horticulture Research Centre, BARI, Joydebpur, Gazipur during the period from November 2016 to May 2017 to find out the performances of nine gladiolus genotypes including BARI Gladiolus-1 used as check. It was revealed from the study that GL-002, GL-031 and GL-037 were found as promising genotypes for selection on the basis of its flower and corm characters such as attractive colour, early flowering, maximum number of florets, longest spikes and rachis, highest weight of spike, longest flower durability and corm and cormel production.

Evaluation of anthurium genotypes

Ten anthurium genotypes along with BARI Anthurium-1 as check were evaluated at Floriculture Field of HRC, BARI during the year 2016-17. The study revealed that there was remarkable variation among the genotypes in both qualitative and quantitative traits. Based on flower colour, spathe size, spadix length, flower number and vase life, AA-004 and AA-007 were found promising to go ahead for varietal development.

Collection and maintenance of heliconia

A study on the performance of six heliconia germplasm was conducted at Floriculture Farm of HRC, BARI, Gazipur during 2016-2017. Wide range of variations for all qualitative and quantitative characters was observed. Based on flower colour, errect habit, shoot number and vase life, H-004, H-005 and H-007 were identified as good genotypes.

Collection, evaluation and maintenance of cactus

Cactus belongs to the family Cactaceae and it is suitable for growing in pots for indoor decoration. Cactus cultivation has become a fascinating hobby among amateur gardeners and these desert plants which are mostly unknown have become the subject of greatest care and delicate handling. Despite of their numerous thorns and spines, they have a beauty of their own. Their hardy nature and easy cultivation in shallow soils are additional features for their popularity. Therefore, a study on the performance of twenty nine cactus genotypes was conducted at Floriculture net house of HRC, BARI, Gazipur during 2016-17.Wide variation in respect of vegetative and floral traits was observed among the genotypes.

Collection and evaluation of euphorbia

Ten genotypes of euphorbia were evaluated at Floriculture Farm of HRC, BARI during the year 2016-17. The results showed wide variations for all qualitative and quantitative characters. Based on flower colour, flower number, stalk length, large flower size and extended flowering duration, the genotype E-001, E-006 and E-007 were identified as promising genotypes for pot culture.

Collection and maintenance of rose

Ten genotypes were collected and maintained at the Floriculture Farm of HRC, BARI, Gazipur and RARS, Jessore. Variation was observed among genotypes in respect of vegetative and floral triats.

Evaluation of aster genotypes

A study on the performance of five aster genotypes was conducted at Floriculture Field of HRC, BARI, Gazipur during 2016-17. Marked variations for all qualitative and quantitative characters were observed. Based on flower colour, flower number, flower size and durability of flower, the genotypes A-001 and A-004 were identified as good genotypes.

Collection, evaluation and maintenance of lily

Seventeen genotypes of lily were evaluated at the Floriculture Field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2016-17. Significant variation on different parameters was observed among the genotypes under study. Based on flower colour, flower size, stalk length and flower durability, L-017 was identified as good genotype.

Studies on variabilities of local dendrobium orchids

An investigation was carried out to find variability and identify morphological characteristics of 15 local Dendrobium orchid germplasm at the Orchidarium of Floriculture Division, HRC, BARI at Joydebpur, Gazipur during the period 2016-17. The results indicated the existence of wide variability among the genotypes on their physio-morphological characters along with yield and yield attributes. Considering flower colour, flower size, flower number and flower durability, D-001 (*D. formosum*), D-004 (*D. parshii*), D-011 (*D. longicornu*) and D-013 (*D. densiflorum*) may be selected as promising germplasm.

Collection and conservation of wild flower germplasm

Bangladesh is unique in having diversified wild flower crop genetic resources in a range of habitats. Their elegance nature and wide range of colours gave them a haunting beauty. Many species, in fact, are widely adapted and found to grow in more than one of these ecological categories. However, these native germplasms are considered threatened due to large-scale destruction of their natural habitat. Therefore, it is needed to collect, characterize and conserve of wild flower germplasm for future research. The experimental material comprised of fourteen genotypes which were collected from across the country and conserved in field gene bank of Floriculture Division of HRC, BARI, Gazipur.

Collection, evaluation and maintenance of lilium

Four germplasm Lil-001, Lil-002, Lil-003 and Lil-004 were collected and planted on November 2016. The experimental field was well prepared by adding 10t cow dung and fertilized @ 300 kg urea, 375 kg TSP and 300 kg MoP. Cow dung, TSP and MoP were applied as basal and urea was top dressed in two equal splits at one month after planting and spike initiation stage. No design was followed and spacing was maintained at 30cm from row to row and 15cm from plant to plant. When the lower most buds showed colour, the spikes were harvested. After collecting flowers, the plants with 3-4 leaves were kept in the field for bulb development. When the leaves were brown and more or less damaged, the bulbs were lifted carefully and stored at coco dust in normal room condition for future planting. Variations were observed in respect of stalk length, florets per stick, floret diameter, petal colour and vase life of the flower stick.

Collection and maintenance of china rose

The experimental material comprised of eleven genotypes which were collected from different nurseries and at the time of data recording age of plants was five years. Intercultural operations such as weeding, watering, manuring, fertilization, disease pest management etc. were done as and when necessary. Data on different traits like flower colour, leaf colour, flower type, flower size, flower number, flower weight etc. were recorded. The genotypes varied widely in respect of flower and leaf colour. The colour of flower was categorized into white, red, orange, pink, sweet and intermediate. Only one genotype (CR-004) had deep green leaf. Rest of the genotypes had light green to green leaf. In regards to flower type, the observed genotypes were categorized into two groups, single and double. Only CR-007 possessed double type flower. The biggest flower was observed in CR-005 (15.0 cm) and smallest in CR-009 (6.0 cm). Maximum flower number was observed in CR-009 (20.0) while maximum flower weight was recorded in CR-007 (8.5 g).

Performance of exotic ornamental gourds lines

Sixteen ornamental cucurbit lines were collected and evaluated at the research field of Floriculture Division, Horticulture Research Centre, BARI, during the season of 2016-17 to observe the adaptability as well as yield and storage duration. Wide variability was observed among the lines. The range of fruit number per plant was 3.0-7.0; fruit weight ranges from 150-500 g. The range of fruit size was 4.0-12.0 cm. Fruit yield varied from 0.5-2.0 kg per plant. Storage duration was good ranging from 155-300 days. Considering attractive fruit colour, shape, size and storage duration, all the line may be selected for detailed study.

Collection and maintenance of tulip

Eight germplasm were collected from Netherlands and used for the study. After vernalization, bulbs were planted to 16.0 cm earthen pot containing media that consists of one part cocodust, two part garden soil and one part cowdung on late October, 2016. Subsequently liquid fertilizers were applied for better growth and development of plants. Other intercultural operations such as watering, weeding, plant protection measures etc. were taken as and when necessary. The germplasm varied widely in respect of flower and leaf colour. The colour of flower was categorized into white, red, yellow, violet and intermediate. Only one genotype had deep green leaf. Rest of the genotypes had light green to green leaf. In regards to flower type, the observed genotypes were categorized into two groups, single and double. Only one germplasm possessed single type flower.

Collection and evaluation of tuberose (*Polianthes tuberosa* L.) genotypes

Six tuberose genotypes with BARI Tuberose-1 as check variety were evaluated at the Floriculture Research Field of HRC, BARI, Gazipur during April 2016 to January, 2017 to know the variability in tuberose genotypes. A wide variation was exhibited in the qualitative parameters like flower type, bud and petal colour, floret arrangement on spike and fragrance. The genotype TR-001, TR-004 and TR-005 produced heavy scented flowers. The quantitative data revealed that, BARI Tuberose-1 required minimum days (17.67) to reach 50% germination of bulbs and also to reach 50% spike emergence (90 days). TR-001 produced the longest spike (86.49cm). The longest rachis (42.18cm) and the maximum number of florets/spike (47.23) were recorded in TR-004. The largest (3.40cm) and the heaviest bulbs (30.0g) were recorded in TR-001. The maximum number of flower sticks/clump (4.33) as well as the maximum flower and bulb yield/ha (266000 spikes and 582,270 bulbs/ha, respectively) were recorded in TR-003. BARI Tuberose-1 remained fresh for the longest time (14.83 days) in the field and also in the vase (7.07 days). The highest percentage of florets (65.63%) was opened by the genotype TR-004. Number of florets showed significantly positive association with rachis length and number of spikes showed significantly positive association with spike length. On the other hand spike length showed negative significant correlation with leaves/clump.

Hybridization of adenium flower

Adenium (*Adenium obesum*) is one of the most important indoor decorative succulent plants in Bangladesh. Breeding of adenium is a fascinating aspect. Different attractive colours, various shape, size and large number of flowers are of demand to the users. So, there is a great scope for developing hybrid varieties in our country. In view of the importance of this crop, hybridization program on adenium was conducted in the flowering season December-January, 2016-17 at net house of Floriculture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur. Crossing was done between two adenium genotypes and pods were successfully produced. Seeds were sown and plantlets are in vegetative stage.

Hybridization of gladiolus flower

Gladiolus is one of the most important cut flower in Bangladesh. Breeding of gladiolus is a fascinating aspect. Different attractive colours, various shapes and large number of florets are demand to the users. So, there is a great scope for hybrid varieties in our country. In view of the importance of this crop, systemic breeding was initiated to produce hybrids. The present study was undertaken with the following objectives as to develop new hybrid varieties.The experiment was conducted at the floriculture field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, during 2016-17. Five gladiolus genotypes were included in this study viz Gl-001, GL-004, GL-012, GL-022 and GL-037. Parents were selected depending on the attractive criteria of flowers like colour, spike length, number of florets/spike etc. Seven crosses were done among 5 parents without following any fashion. Pollination was done in the morning. One day before pollination, emasculation was done. Recommended dose of fertilizers were applied and intercultural operations were done as and when necessary. After that, a successive cultivation procedure was maintained until getting flowering. After inter specific hybridization among 5 gladiolus genotypes, 100% pods were produced. Pods were collected after maturity and subsequently seeds were sown in pot.The time was taken to pod maturity ranges from 30-45 days. Finally, 3 new hybrids have been developed.

Induction of variability through gamma radiation in gladiolus

The present investigation was conducted and the emphasis was given to find out desirable variations caused by gamma radiations and also to develop a new variety by fixing the induced variation in succeeding generations.The experiment was carried out at Floriculture Research Field of HRC, BARI, Gazipur during 2016-17. Three gladiolus varieties (BARI Gladiolus-4, BARI Gladiolus-5 and BARI Gladiolus-6) were considered as one factor and the other factor was gamma radiation with five levels (0, 60, 80, 100 and 120 gray). Medium sized corm of these varieties were irradiated with gamma rays at Institute of Food and Radiation Biology under Bangladesh Atomic Energy Commission, Savar and planted on November 2016. The experiment was laid out in RCB factorial design with 3 replications. The unit plot size was 2.5 m x 2.0 m and spacing was maintained at 20 cm from row to row and 20 cm from plant to plant. The experimental field was well prepared by adding 10 t cowdung and fertilized @ 300 kg urea, 375 kg TSP, 300 kg MoP, 2.0 kg B, 3.0 kg Zn and 20.0 kg S per hectare. Cowdung, TSP, MoP, B, Zn and S were applied as basal and urea was top-dressed in two equal splits at 4 leaf stage and spike initiation stage.Management practices like irrigation, weeding, mulching etc. were same for all treatments during entire period of study. The spikes were cut when lower 2-3 florets showed their blushes of colour. The data on growth, flower and corm characters were recorded from ten randomly selected plants from each unit plot. From the above result, it was observed that BARI Gladiolus-4 showed better performances in respect of vegetative and flower characters but BARI Gladiolus-5 produced better corm production. In vM_1, BARI Gladiolus-6 showed some changes in petal colour but BARI Gladiolus-4 and BARI Gladiolus-5 did not show any changes. In vM_2, BARI Gladiolus-4 produced attractive flower stick (different floret showed different colour) and BARI Gladiolus-6 continued the colour changes in petals like the previous year. These materials should be maintained separately for bringing the stability of petal colour in gladiolus varieties.

Effect of varieties and planting materials on growth, flowering and bulb production in tuberose

The experiment was carried out at floriculture research field of HRC, BARI, Gaziput during 2016-17 to find out the suitable planting materials for specific tuberose genotypes for growth, flowering and bulb production of tuberose. Individually both genotypes showed better performances for some specific parameters and large bulb showed best results among different planting materials. As there were no significant variations among the various combination of tuberose varieties and planting materials on growth and flowering of tuberose, so all the planting materials including mother bulb couple with both genotypes may be used for tuberose flower production.

Influence of maturity stages on seed quality of China aster

A study was conducted at Floriculture Research Field of HRC, BARI during the winter season of 2016-17 to find out the optimum maturity stages of China aster seed. Two genotypes A_1 and A_2 (standard white and standard pink) and 6 maturity stages viz. 21, 28, 35, 42, 49 and 56 DAF (days after flowering) were included in this study. Among the genotypes A_2 responded better in seed quality parameters and 42 DAF was found optimum for harvesting seed for both the genotypes.

Foliar application of GA_3 on growth and flowering of standard chrysanthemum

The experiment of foliar application of GA_3 on growth and flowering of standard chrysanthemum was carried out at the Floriculture Research Field of HRC, BARI, Gazipur during September 2016 to May 2017. Cuttings of white coloured standard chrysanthemum have been collected from previously grown suckers and planted in seed bed in last week of September, 2016 for root initiation. These chrysanthemum seedlings were transplanted in the main field on November, 2016. The two factor experiment was laid out in Randomized Complete Block (RCB) Design with three replications. Frequency of GA_3 application with three levels (one spray, two sprays and three sprays) was considered as one factor. The other factor was GA_3 concentration (ppm) with five levels (50 ppm, 75ppm, 100ppm, 150 ppm and control). Water was sprayed in control treatments. GA_3 at different concentrations was sprayed 25, 50 and 75 days after transplanting of the seedlings as per treatments. The unit plot size was 1.5 m x 2.4 m and spacing was maintained at 30cm x 30cm. The experimental field was well prepared by adding 10-12t cowdung and fertilized @ 400 kg urea, 275 kg TSP and 300 kg MoP/ha. Cowdung, TSP and MoP were applied as basal and urea was top-dressed in two equal splits at 25 and 50 days after transplanting. The data on growth, flower and bulb characters were recorded from ten randomly selected plants from each unit plot during the study period. Three and two times spray of GA_3 application took the minimum days to reach bud burst (24.99 and 25.29days, respectively) and full blooming (35.61 and 35.94days, respectively) and also produced longer plant (44.92 and 43.63cm, respectively) compare to one spray. GA_3 at 150 ppm concentration took minimum days to reach bud initiation to full blooming and longer plants (53.87cm). Regarding flowering parameters, three and two sprays of GA_3 produced maximum marketable branch (6.52 and 6.43, respectively), flowers/marketable branch (6.99 and 6.95, respectively), flowers/plant (47.14 and 46.70, respectively), flower durability (82.80 and 82.0, respectively) and % flowering plants (28.45 and 30.0, respectively). GA_3 at 150 ppm also showed better performances in all the flowering parameters compare to water and other GA_3 spray. Though two times sprays with 150 ppm GA_3 showed better performance considering growth and flowering parameters but GA_3 at 150 ppm for one time spray may be recommended for commercial chrysanthemum (Standard White) flower production considering the highest marginal rate of return.

Standardization of potting media on sansevaria

The present investigation was carried out at Floriculture Division, HRC, BARI at Joydebpur, Gazipur during the period from 2016-2017. Sansevaria sucker was used as planting material. The basic substrates were cocodust, perlite and soil which were used singly and in combinations. All the mixtures were made on v/v basis. Liquid fertilizer was applied for getting better growth. The experiment was laid out in RCB design with 3 replications. Data on different parameters like survivability %, plant height, number of leaves, leaf size, number of suckers, plant spread etc. were recorded. The treatment 50% cocodust with 25% cowdung and 25% soil was found to be the best media in respect of growth characteristics of Sansevaria.

Effect of varieties and disbudding on quality cut flower production of chrysanthemum

The experiment was carried out at Floriculture Research Field of HRC, BARI, Gazipur during *rabi* season of 2016-17. Chrysanthemum genotypes–standard white and standard yellow combination with six level of treatment viz, no disbudding, allowing 4 blooms/plant, allowing 5 blooms/plant, allowing 6 blooms/plant, Allowing 7 blooms/plant and Allowing 8 blooms/plant. The experiment was laid out in RCB factorial design with 3 replications. The unit plot size was 1.8m ×3.0m. Spacing was maintained at 30 cm from row to row and 30 cm from plant to plant. Healthy and uniform seedlings of two genotypes were planted on November, 2016. Experimental plots were thoroughly drenched with Bavistin @ 2 mg/L. The experiment field was well prepared by adding 10t cowdung and fertilized @ 400 kg urea, 275 kg TSP and 300 kg MoP/ha, Cowdung, TSP and MoP were applied as basal and urea was top-dressed in two equal splits at 25 and 50 days after transplanting of seedlings. The data on plants survived/plot, days to bud initiation, days to bud burst, stalk length, flower diameter, flower sticks/plot and number of sticks/ha were recorded from five randomly selected plants of each unit plot. Considering the chrysanthemum cut flower production, standard white showed better performance due to its longer stalk. If attractive yellow color and flower diameter are taken under consideration standard yellow may be selected as cut flower. Regarding disbudding, 4blooms/plant may also be taken into acount for chrysanthemum cut flower production.

Effect of plant growth regulators on growth, flowering and yield attributes of marigold

The experiment was carried out to asses the optimum concentration of various growth regulators to cause beneficial effect on growth and flowering behaviour of marigold during summer season of 2016-17 at floriculture field of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur. The experiment was conducted in randomized block design with ten treatments comprising of three levels each of gibberellic acid (100, 200, 300 ppm), Ethrel (100, 200, 300 ppm) and Naphthalene acetic acid (100, 200, 300 ppm) along with control (without growth regulator) replicated thrice to evaluate the effect of these plant growth regulators on growth, flowering and yield attributes in marigold. The observed vegetative traits like plant height, numbers of branches, plant spread and different flowering as well as yield attributing traits like early flower bud initiation, opening of first flower, maximum duration of flowering and flower yield were found to be maximum from the treatment gibberellic acid @ 300 ppm as compared to other treatments.

Development of floral arrangement

Since the beginning of time flowers have been used to celebrate. They are appropriate to so many different occasions, so many different feelings and experiences. A simple bunch given to a friend or someone or a decoration in the home for a special occasion adds a special touch. In times of happiness flowers can blaze with pomp and glory, jostle noisily with fun; in serenity, they can be tranquil, and in times of sadness they can be a solace. Flowers are a comfort and an expression of joy, with a beauty that bright the most ordinary or miserable of days. The greens foliage is tremendously important in flower arrangements. They bring to life the colors of the flowers with which they are arranged. Ikebana, a recent development in Bangladesh, is an important branch of ornamental horticulture. It is one of creative activities that produce an enjoyable sensation of enjoyment. Various colours and form combinations are possible through matching and contrasting flowers and foliage and their training in it to fulfill the urge for creation. However, this type of research is scarce in Bangladesh. Therefore, investigations on floral arrangement techniques were successfully developed.

Breeder's seed/propagule production of flower crops

A good number of varieties under different flower crops have been developed and released for countrywide cultivation. Moreover, a considerable number of commercial/promising flower varieties are available in floriculture. These materials need vegetative propagation for maintaining their mother's characters. Considering this, the present work was undertaken to multiply the selected flower crops. However, 35000 seedlings/ propagules of different flower crops were produced under this study.

Adaptive trial of gladiolus varieties at farmer's field

The aesthetic value of flowers in the daily life is increasing with the advancement of civilization. Gladiolus is used as cut flower in Bangladesh. The major production belts of this flower in the country are Jessore sadar, Sharsha, Chowgacha, Kushtia, Chuadanga, Satkhira, Khulna, Chittagong, Mymensingh, Dhaka, Savar, Narayangonj and Gazipur regions. Now a days, farmers are cultivating different cultivars of gladiolus in different locations. However, yield potential of those cultivars is not known and some of them are not performing well in our country. BARI has developed 6 varieties of gladiolus which have high potential in yield and other characters but these varieties are not widely cultivated in Bangladesh. Therefore, quick dissemination and popularization of BARI released gladiolus variety is urgently needed. Widespread and effective demonstration of them at farmers' field will lead to ensure availability of gladiolus flowers in Bangladesh. Trials were conducted at Chaurasta (Gazipur), Sonatola (Bogra), Godagari (Rajshahi), Godkhali (Jessore) and Burirhat (Rangpur) during Rabi, 2016-2017. These experiments were laid out in RCB design with three dispersed replications. The unit plot was 1500 m^2 areas with plant spacing of 20×20 cm. Four varieties of gladiolus viz. BARI Gladiolus-1 (Red), BARI Gladiolus-3 (White), BARI Gladiolus-4 (Pink) and BARI Gladiolus-5 (Yellow) were included in the trial. The field was well prepared by adding 10 t cowdung and fertilized @ 200 Kg N, 50 Kg P, 150 Kg K, 20 Kg S, 2 kg B and 3 kg Zn/ha. Cowdung, P, K, B, S and Zn were applied as basal and N was top-dressed in two equal splits at 4 leaf stage and spike initiation stage. Intercultural operations and pest management practices were done as and when necessary. The spikes were cut when lower 2-3 florets showed their blushes of colour. The data on yield and yield contributing characters were taken. The varieties BARI Gladiolus-3, BARI Gladiolus-4 and BARI Gladiolus-5 showed better performance and produced higher yield at all locations. The demand of BARI Gladiolus-3 and BARI Gladiolus-5 were more in Gazipur, Rajshahi and Bogra because of consumer's choice, economic value and early flowering habit of those varieties. But the demand of BARI Gladiolus-3 and BARI Gladiolus-4 were more in Rangpur and Jessore.

Adaptive trial of tuberose varieties at farmer's field

Tuberose (*Polianthes tuberosa* L.) is an important cut flower in Bangladesh from aesthetic as well as commercial point of view. It is suitable for use in herbaceous borders, beddings, pots and for cut flowers. Sometimes it is used for loose flower also. Apart from ornamental value, tuberose is extensively utilized in medicines for headache, diarrhoea, rheumatism and allied pains. Due to its increasing demand, farmers have started growing tuberose as a field crop under different management practices. Good variety, proper spacing, optimum size of bulbs, fertilizer requirement, irrigation schedule, use of growth regulators, optimum time of planting etc. are some of the important factors that may help to increase the yield and quality of tuberose. The major production belts of this flower in the country are Jessore sadar, Sharsha, Chowgacha, Kushtia, Chuadanga, Rangpur, Bogra, Satkhira, Khulna, Chittagong, Dhaka, Savar and Gazipur regions. Now a days, farmers are cultivating different cultivars of tuberose in different locations. However, yield potential of those cultivars is not known and some of them are not performing well in our country. BARI developed tuberose variety that need to be popularize among the farmers. To do so, on-farm trial is one of the ways to demonstrate better performance of the variety. Therefore, trials on BARI Tuberose-1 with promising line (PT-001) as check were conducted at Chaurasta (Gazipur), Sonatola (Bogra), Godagari (Rajshahi), Godkhali (Jessore) and Burrirhat (Rangpur) during summer season of 2017. The experiment was laid out in RCB design with two dispersed replications. The unit plot was 1500 m^2 areas with plant spacing of 30 × 20 cm. Bulbs of BARI Tuberose-1 along with check (PT-001) were used as planting material. Manure, fertilizer, insecticide, fungicide, netted bag, secateurs etc. were supplied for making availability of inputs among the farmers in time. The experimental field was well prepared by adding 10t cowdung and fertilized @ 435 kg urea, 400 kg TSP, 300 kg MoP, 12 kg boric acid and 8 kg $ZnSO_4$/ha. Cowdung, TSP, MoP, boric acid and $ZnSO_4$ were applied as basal and urea was top-dressed in two equal splits at 30 days after planting and spike initiation stage. Farmers are interested to cultivate the new variety of BARI Tuberose-1 for getting higher yield over local variety at all locations. They also preferred BARI Tuberose-1 because there was no incidence of pest and disease recorded in the field. On the other hand, benefit cost ratio was also higher in BARI Tuberose-1.

Adaptive trial of marigold variety at farmer's field

Marigold gained popularity amongst gardeners and flower growers on account of its easy culture and wide adaptability. Its habit of free flowering to produce marketable flowers, wide spectrum of attractive colour, shape, size and good keeping quality attracted the attention of flower growers. BARI developed summer marigold variety that needs to be popularizing among the farmers. To do so, on-farm trial is one of the ways to demonstrate better performance of the variety. Trials were conducted on BARI Marigold-1 at Chaurasta (Gazipur), Sonatola (Bogra), Godagari (Rajshahi), Godkhali (Jessore) and Burrirhat (Rangpur) during the summer season of 2017. The experiment was laid out in RCB design with two dispersed replications. The unit plot was 1500 m^2 areas with plant spacing of 40 × 40 cm. cuttings of BARI Marigold-1 was used as planting material. The experimental field was well prepared by adding 10t cowdung and fertilized @ 350 kg urea, 300 kg TSP, 275 kg MoP, 12 kg boric acid and 8 kg $ZnSo_4$/ha. Cowdung, TSP, MoP, boric acid and $ZnSo_4$ were applied as basal and urea was top-dressed in two equal splits at 30 days after planting and flower initiation stage. Farmers are interested to cultivate the new variety of BARI Marigold-1 for getting higher yield over local variety at all locations. They also preferred BARI Marigold-1 because there was no incidence of pest and disease recorded in the field. On the other hand, benefit cost ratio was also higher in BARI Marigold-1.

Crop Management

Effect of irrigation interval on the bulb yield and storability of garlic

The experiment was conducted at Joydebpur and Ishurdi farm of Bangladesh Agricultural Research Institute during *rabi* season of 2016-17 to make an effective irrigation schedule for getting maximum bulb yield of garlic and subsequent effect on storability. The experiment consisted of four treatments viz. I_1= Irrigation at 10 days interval, I_2= Irrigation at 15 days interval, I_3= Irrigation at 20 days interval and I_4= Irrigation at 25 days interval. Irrigation was applied following the schedule and it was maintained up to the field capacity. Two irrigations were applied just after clove planting and at 30 days after planting for stand establishment of the crop. The crop received 88.0 mm rainfall at Joydebpur and 397mm at Ishurdi during its growing period. The crop was planted on 15 November 2016 at Joydebpur and 6 November 2016 at Ishurdi. Fertilizer was applied @ 100-152-165-20-4 kg ha^{-1} of N-P-K-S-Zn, respectively. Half of N and all other fertilizers were applied at final land preparation. Remaining N was applied as top dressed at 25 and 50 days after emergence. Weeding was also done at 25 and 50 days after emergence of garlic. Soil moisture was monitored before irrigations by gravimetric method. Irrigation was stopped 25 days before harvest of garlic. The crop harvested on 23 March 2017 at Joydebpur and 25 March 2017 at Ishurdi. Data on yield and yield contributing characters were taken and analyzed statistically. The treatment mean values were compared by using LSD at 0.05 levels of significance. Garlic bulb of different treatments was stored in an ambient condition just after harvest to observe the subsequent effect of irrigation schedule up to 180 days. Amount of 5 kg garlic of each treatments were stored on wooden rake with replicated three times. Data on bulb sprouting, rotting and total weight loss were recorded at 30 days intervals. Irrigation interval significantly influenced the plant height and bulb yield in both the locations. The increase in irrigation intervals affected bulb yield. The highest bulb yield (7.91 t/ha at Joydebpur and 5.70 t/ha at Ishurdi) was obtained from 10 days interval irrigation was followed by 15 days interval (7.5 t/ha at Joydebpur and 5.53 t/ha at Ishurdi). The consumptive use of water was also the highest when irrigation was scheduled at 10 days interval irrespective of location. But WUE was higher with 25 days irrigation interval. In storage, loss of bulb weight was more in short irrigation interval than long interval. The weight loss was maximum in first month than second month. The highest gross return (Tk. 791000/ ha at Joydebpur and Tk. 570000 /ha at Ishurdi), gross margin (Tk. 521094 /ha at Joydebpur and Tk. 301094 /ha at Ishurdi) and BCR (2.93 at Joydebpur and 2.12 at Ishurdi) were obtained from 10 days irrigation interval followed by 15 days irrigation interval. Application of irrigation water at 10-days interval might be optimum for getting higher bulb yield of garlic in both the locations.

Effect of fertilizer management on fruit yield of Bt. brinjal at Joydebpur

The experiment was conducted at Agronomy field of Bangladesh Agricultural Research Institute, Gazipur 1701 to evaluate the performance of Bt. brinjal under different nutrient levels. The treatments were T_1= STB Recommended dose (120-36-90-15-2-1 kg/ha of N-P-K-S-Zn-B+ 3 t/ha poultry manure) (FRG' 2012), T_2 = T_1 + 25% of NPK (150-45-112-18-2.5-1.25 kg/ha of N-P-K-S-Zn-B +3 t/ha poultry manure), T_3= T_1 + 50% of NPK (180-54-135-22-3-1.50 kg/ha of N-P-K-S-Zn-B +3 t/ha poultry manure), T_4= T_1 + 25% of NPK + 3 t/ha poultry manure (150-45-112-18-2.5-1.25 kg/ha of N-

P-K-S-Zn-B+6 t/ha poultry manure), $T_5 = T_1 + 3$ t ha^{-1} poultry manure (120-36-90-15-2-1 kg/ha of N-P-K-S-Zn-B + 6 t/ha poultry manure). The experiment was conducted in RCB design with three replications. BARI Bt. Begun-2 was used as test crop. Plant spacing was 90 cm × 80 cm. All of poultry manure, phosphorus, sulphur, zinc and boron were applied at the time of final land preparation. Nitrogen and potassium were applied in four equal splits at 20, 40, 60 and 80 DAT around the plants and mixed thoroughly with the soil. Plant height, canopy coverage/plant and fruits/plant showed significant variation among the fertilizer doses except days to flowering. Plant height was found the highest in T_3 (48 cm) which was statistically similar to T_2 and T_4. Similar trend was observed in the case of canopy coverage/plant and fruits/plant. Canopy coverage/plant was the highest (1.26 m^2) in T_3 but the lowest in T_1. The results indicated that higher fertilizer doze enhanced crop growth. Fruits/plant was observed the highest (93) in T_3 followed by T_4 while the lowest in T_1. Higher fertilizer dose increased number of fruits/plant. Plant required 110-114 days for flowering. Higher fruit length (14.00-14.44 cm) of Bt. brinjal was observed in T_2, T_3, and T_4 but diameter was noticed higher in T_3 and T_4 (4.49-4.62 cm). Individual fruit weight was the highest in T_3 (83 g) but the lowest in T_1 (72 g). Fruit yield was recorded the highest in T_3 (63.23 t/ha) followed by T_4 (48.28) and T_2 (46.77 t/ha) but producing the lowest in T_1 (17.45 t/ha). The results expressed that higher fertilizer dose increased fruit yield of Bt. brinjal as compared to recommended dose of brinjal. Yield of Bt. brinjal is higher as a results of fertilizer requirement of Bt. brinjal is higher. Fruit yield was significantly correlated with applied nutrients (r=0.97 at p=0.01). Functional relationship between applied nutrient and fruit yield of Bt. brinjal indicated that effect of nutrient on the fruit yield of Bt. was 92% ($Y=0.31x-56.37$, $R^2 = 0.92$). Gross return (Tk. 1264600/ha), gross margin (Tk. 1094360/ha) and BCR (7.43) were computed the highest in T_3 followed by T_2 and T_4. The results revealed that higher fertilizer dose gave higher monitory advantage. Nutrients dose, 180-54-135-22-3-1.50 kg/ha of N-P-K-S-Zn-B +3 t/ha poultry manure was required for higher yield of BARI Bt. Begun-2 (63.23 t/ha) representing higher gross return (Tk.1094360/ha) and BCR (7.43) at Joydebpur region.

Performance of hybrid maize varieties in *kharif* season

A field experiment was undertaken at the Agronomy Research Field, BARI, Gazipur and the Regional Agricultural Research Station, Jamalpur during kharif season of 2016 to find out suitable hybrid maize variety (s) for obtaining maximum yield. Six hybrid maize varieties viz., BARI Hybrid maize-5 (BHM-5), BARI Hybrid maize-7 (BHM-7), BARI Hybrid maize-9 (BHM-9), 900 M Gold, Miracle and NK-40 were evaluated. The experiment was laid out in randomized complete block design and the unit plot size was 6 m × 5 m. Seeds of all hybrid maize varieties were sown on 15 February, 2016 at Joydebpur; 9 February, 2016 at Jamalpur. Fertilizer dose and application methods were same in both locations. Fertilizers were applied at the rate of 256-76-121-72-5-1 kg/ha of N-P-K-S-Zn-B (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid, respectively. One third of N, whole amount of TSP, MoP, gypsum, zinc sulphate and boric acid were applied as basal. Remaining 2/3 N was top dressed at 20 and 40 days after sowing (DAS). To record dry matter weight and leaf area, two plants were sampled in each plot at 10-day intervals from 20 to 90 DAS and at harvest. Dry weight of the samples was taken after drying at 80^{0}C in an oven for 72 hours. Leaf area was measured by an automatic leaf area meter (L13100 c, L1COR, USA). Growing degree day (GDD) was calculated using the following formula: GDD $= \frac{T\max + \text{T}\min}{2} - T\ base$

Where, T_{max} and T_{min} are daily maximum and minimum temperatures, respectively. T_{base} indicated base temperature. For maize it is 8^{0}C. GDD can be summed over days to indicate the amount of heat acumulation for growth that the crop has received over any period of the growing season (Ahmed *et al*, 2016). Varietal variations showed great influence on dry matter (DM) production, leaf area index (LAI), yield and yield components in both the locations. Variety Miracle produced the highest DM and LAI which were similar to those of 900 M Gold, NK-40 and BHM-9. These parameters finally contributed to higher yield in Miracle, 900 M Gold, NK-40 and BHM-9 than the other two varieties in both the locations. Miracle and 900 M Gold took the longest period (102 days at Joydebpur and 107 days at Jamalpur) to attain the physiological maturity and the shortest period was needed by BARI released varieties with lower GDD in both the locations. The highest grain yield (9.89 t/ha at Joydebpur and 10.15 t/ha at Jamalpur) was recorded in Miracle but it was statistically similar to 900 M Gold, NK-40 and BHM-9 in both the locations. The results revealed that Miracle, 900 M Gold, NK-40 and BHM-9 might be suitable for growing in kharif season. Considering lower price of seed, variety BARI Hybrid maize-9 may be given priority/preference.

Performance of hybrid maize as affected by sowing date after potato harvest

A field experiment was conducted at Joydebpur, Gazipur and Burirhat, Rangpur, Bangladesh Agricultural Research Institute during Kharif season 2016 to find out appropriate sowing date of hybrid maize (var. BARI Hybrid Bhutta-9) followed by potato harvest. Seven planting dates included in the experiment were: February-01, February-07, February-14, February-21, February-28, March-7 and March-14. The design of the experiment was RCB. Unit plot size, variety and spacing were same in both locations. The unit plot size was 6 m × 5 m. The variety was BARI Hybrid maize– 9 (BHM-9). The spacing was 60 cm × 20 cm. Fertilizer dose and application methods were also same in both locations. Fertilizers were applied at the rate of 256-76-121-72-5-1 kg/ha of N-P-K-S-Zn-B (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid, respectively. One third of N, whole amount of TSP, MoP, gypsum, zinc sulphate and boric acid were applied as basal. Remaining 2/3 N was top dressed at 20 and 45 days after sowing (DAS) followed by irrigation. Data on yield and yield contributing characters were recorded in both locations and growth parameters like leaf area and dry matter accumulation were measured at different growth stages at Joydebpur. To record dry matter weight and leaf area, two plants were sampled in each plot at 10-day intervals from 20 to 90 DAS and at harvest. Dry weight of the samples was taken after drying at 80^0C in an oven for 72 hours. Leaf area was measured by an automatic leaf area meter (L13100 c, L1COR, USA). Growing degree day (GDD) was calculated using the following formula: GDD

$$= \frac{T\max + \mathrm{T}\min}{2} - T\ base$$

Where, T_{max} and T_{min} are daily maximum and minimum temperatures, respectively. T_{base} indicated base temperature. For maize it is 8^0C. GDD can be summed over days to indicate the amount of heat accumulation for growth that the crop has received over any period of the growing season. The crop was harvested at physiological maturity in both locations. Sowing date variations showed great influence on dry matter (DM) production, leaf area index (LAI), yield and yield components in both the locations. Earlier three sowing dates (February-01, February-07 and February-14) produced the higher dry matter (DM) and leaf area index (LAI). These parameters finally contributed to higher yield in earlier three sowing date than other sowing dates in both locations. First sowing (February 01) took the longest period (101 days with 1790 GDD at Joydebpur and 111 days with 1777 GDD at Burirhat to attain the physiological maturity and the shortest period was needed by the last sowing date (94 days with 1784 GDD at Joydebpur and 100 days with 1788 GDD at Burirhat). The higher grain yield (9.18-8.99 t/ha at Joydebpur and 10.48- 10.14 t/ ha at Burirhat) was recorded in earlier three sowing date. The lowest grain yield (5.10 t/ ha at Joydebpur and 6.54 t/ ha at Burirhat) was recorded in the last sowing date. Grain yield showed in decreasing trend with delayed sowing after potato harvest.

Effect of twig removal on yield of pea varieties

The experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur and RARS, Burirhat, Rangpur during rabi season of 2016-17 to evaluate the effect of twig removal, and on the yield and yield attributes of pea varieties. Treatments consisted of three varieties such as V_1= Natore local, V_2 = BARI Motorshuti -1 and V_3= BARI Motor -1and and five twig removal T_1= control (no removal), T_2= removal of 5 cm twig at 25 DAE, T_3= removal of 7.5 cm twig at 25 DAE, T_4= removal of 10 cm twig at 35 DAE, T_5 = removal of 12.5 cm twig at 35 DAE. Natore local cultivar was not included at Burirhat due to unavailability of seed. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 3 m × 3 m. Seeds of pea varieties were sown on 27 November, 2016 at Joydebpur and 21 November, 2016 at Burirhat. Fertilizers were applied at the rate of 35-20-25-10 kg/ha of N-P-K-S kg/ha (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MOP) and gypsum. Half of N, whole amount of TSP, MOP and gypsum was applied as basal. Remaining was top-dressed at 35 days after emergence (DAE). The crop was harvested on 23 and 27 February, 2017 in both location. Leafy vegetable yield varied among the varieties and level of twig removal. Leafy vegetable yield was maximum (779 kg/ha at Joydebpur and 700 kg/ha at Burirhat) in BARI Motorshuti-1 when 12.5 cm twig removal at 35 DAE. Significantly the highest pod yield (10.14 t/ha at Joydebpur and 8.14t/ha at Burirhat) was recorded from BARI Motorshuti-1 when 5 cm twig removal at 25 DAE which was statistically similar to same variety with 7.5 cm twig removal at 25 DAE only at Joydebpur. The lowest pod yield (4.91 t/ha) was obtained from Natore local when 12.5 cm twig removal at 35 DAE whereas, at Burirhat the lowest pod yield (4.11 t/ha) was in BARI Motor -1. At Joydebpur, the highest gross return (Tk 82539.50 /ha), gross margin (Tk 56679.50/ha) and BCR (3.19) was recorded in BARI Motorshuti-1 when 7.5 cm twig removal at 25 DAE which was similar to same variety with 5 cm twig removal at 25 DAE . At Burirhat, the highest gross return (Tk.83212/ha) and BCR (3.11) were recorded in BARI Motorshuti-1 when 5 cm twig removal at 25 DAE which was similar to same variety with 7.5 cm twig removal at 25 DAE and the lowest in no removal with BARI Motor -1 . The result revealed that 5- 7.5 cm twig removal at 25 DAE from tip as vegetable might be profitable technique for pea grain production.

Growth and yield of popcorn as influenced by plant spacing and fertilizer management

The experiment was conducted at the research field of Agronomy Division BARI, Joydebpur, Gazipur and RARS, Burirhat, Rangpur during rabi season of 2016-17 to find out optimum plant spacing and fertilizer dose of popcorn for higher yield and economic return. The soil was clay loam in texture with p^H 6.1. The experiment was laid out in a randomaized complete block design with three replications. The unit plot size was 4 m × 3.6 m. Two plant spacing viz, S_1= 45 cm × 20 cm (1,11,111plants/ha), S_2= 60 cm × 20 cm (83,333 plants/ha) and six fertilizer doses viz, F_1 = 120- 35- 70- 40- 5- 1.5 kg /ha NPKSZnB (RFD), F_2= F_1 + 20% NPK, F_3= F_1 + 30% NPK, F_4= F_1 + 40% NPK, F_5= F_1 + 50% NPK and T_6 = Native nutrient (Control) were used in the study. Seeds of popcorn (var. BARI Khaibhutta-1) was sown on 17 Noverber 2016 at Rangpur and 29 November 2016 at Joydebpur. Fertilizers were applied as per treatments in the form of Urea, TSP, MoP, Gysum, Zinc sulphate and Boric acid. One-third of urea and full amount of all other fertilizers were applied at the time of final land preparation. The remaining Urea was top dressed in two equal splits at 8-10 leaf stage (35 DAS) and tasselling stage (55 DAS). A light irrigation was given after sowing of seeds for germination. Three irrigations were done at 30, 60 and 90 DAS. Intercultural operations like thinning were done at 15 DAS and weeding was done two times at 15 and 25 DAS. Leaf area measured by an automatic leaf Area Meter (L13200 C, LICOR, USA). For dry matter estimation, 5 plants were sampled at 20 days interval up to maturity. The collected samples were dried component wise in an oven at 80^oC for 72 hours. Popcorn was harvested on 25 March 2017 at Rangpur (130 days after sowing) and 16 April 2017 at Joydebpur (139 days after sowing). Result reveled that plant spacing of 45 cm x 20 cm with fertilizer dose of 180-53-105- 40- 5- 1.5 kg/ha (F_5) gave the highest grain yield (5.82 t/ha) and highest benefit cost ratio (1.77) at Joydebpur and plant spacing of 60 cm x 20 cm with fertilizer dose of 180-53-105- 40- 5- 1.5 kg/ha (F_5) gave the highest grain yield (7.11 t/ha) and highest benefit cost ratio (1.80) at Burirhat, Rangpur.

Effect of foliar application of N, Zn and B on growth and yield of tomato

A field experiment was conducted at the research field of Agronomy Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during *rabi* seasons of 2015-16 and 2016-17 to investigate the effect of foliar application of N, Zn and B as singly or in combination on fruit size, number and yield of tomato and also to find out the optimum nutrient concentration for maximum yield of tomato. There were eight nutrient concentration viz. T_1= control, T_2= N (0.08%), T_3= Zn (0.05%), T_4= B (0.03 %), T_5= N (0.08%) + Zn (0.05%), T_6= N (0.08%) + B (0.03%), T_7= Zn (0.05%) + B (0.03%) and T_8= N (0.08%) + Zn (0.05%) + B (0.03%) were used as treatment. The experiment was laid out in randomized complete block design (RCB) with three replications. The unit plot size was 3 m × 1 m. The required amount of nutrients were dissolved in tap water to get desired concentrations and the solution was applied with Knap sack sprayer as a foliar feeding at 15 and 21 days after transplanting. The sources of these nutrients were urea, boric acid and zinc sulphate. The main field was fertilized with cowdung 10 t ha^{-1} and 131-43-37 kg/ha N-P-K respectively (soil test base).Entire TSP, ½ cowdung and ½ MoP were used at final land preparation and rest ½ cowdung was applied during pit preparation. Rest ½ MoP and whole urea were top dressed at three equal installments at 10, 25 and 40 days after transplanting. BARI Tomato-15 was used as a variety in this experiment. Seeds were sown on 29 October 2015 (1^{st} year) and 30 October 2016 (2^{nd} year) and transplanted in main field on 1 December 2015 (1^{st} year) and 1 December 2016 (2^{nd} year). Plant to plant distance was 40 cm and row to row distance was 60 cm. The tallest plant (93.5 cm and 91.3 cm),the highest fruit/plant (34.43 and 39.2), the maximum fruit weight/plant (2067g and 1970g), single fruit weight (68.04g and 54.87g) and the highest yield (92.59 t/ha and 90.22 t/ha) were found in foliar spray of N (0.08%) + Zn (0.05%) + B (0.03%) along with the basal dose of 131-43-37 kg / ha of N-P-K + cowdung 10 ton / ha in 2015-16 and 2016-17,respectively. Two years results revealed that the foliar application of macro (N) and micro (Zn and B) nutrients enhanced fruit size, fruit weight and yield/ ha of tomato. The highest tomato yield were found in T_8= N (0.08%) + Zn (0.05%) + B (0.03%) treatment. So, foliar application of NZnB was suitable for tomato production.

Phenology, dry matter accumulation and yield of summer onion in relation to planting time

A field experiment was conducted at Agronomy field, Joydebpur, Gazipur and RARS, burirhat, Rangpur, during the *kharif* season of 2015 and 2016 to find out the optimum planting time for getting maximum yield and also to study the phenology and dry matter partitioning of summer onion (var. BARI Piaz-5). Nine sowing dates viz. D_1= 1 February, D_2= 1 March, D_3= 1 April, D_4= 1 May, D_5= 1 June, D_6= 1 July, D_7= 1 August, D_8= 1 September and D_9= 1 October were the treatments. The experiment was laid out in randomized complete block design (RCB) with three replications. The unit plot size was 2 m × 1.2 m. Fertilizer was applied at the rate of 84-40-80-40-2.3-1.5 N-P-K-S-Zn-B + cowdung (5 t/ha). BARI Piaz-5 was used as variety of summer onion. The maximum yield of onion (at Joydebpur: 23.75 t/ha in 2015 and 22.75 t/ha in 2016 and at Burirhat: 22.15 t/ha in 2015 & 21.92 t/ha in 2016) was obtained from 1 October planting. Two years results revealed that, 1 February to 1 April for *kharif*-I season and 1 October in *kharif*-II season might be the optimum sowing date for summer onion. The result also indicated that July to August sowing is not suitable for summer onion production.

Effect of fertilizer management on fruit yield of Bt. brinjal at Dinajpur

The experiment was conducted at the research field of Agricultural Research Station, Rajbari, Dinajpur during *rabi* season of 2016-17 to increase the productivity and to develop a profitable fertilizer dose for Bt begun. Five different treatments were viz. T_1= STB Recommended dose (FRG, 2012), T_2= T_1+ 25% of NPK, T_3 = T_1+ 50 % of NPK, T_4 =T_1+ 25% of NPK + 3 t/ha poultry manure, and T_5 = T_1 + 3 t/ha poultry manure were used in the study. The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 5.4 m×4.0 m. The land of the experimental plot was prepared with a power tiller by ploughing and cross ploughing followed by laddering and the soil was brought into good tilth. Half of organic manure was applied at the time of final land preparation. Remaining organic manure and all of phosphorus, sulphur, zinc and boron were applied in pit before one week of transplanting seedlings. Nitrogen and potassium were applied in four equal splits at 20, 40, 60 and 80 DAT as ring method around the plants and mixed thoroughly with the soil. Intercultural operations like watering, weeding and pest control were done as and when required. First harvesting of brinjal was done at 112 DAP and the harvesting was continued up to 160 DAP. Yield components of brinjal were taken from randomly selected 10 plants from each plot. Fruit yields were taken from whole plot. Collected data were analyzed statistically by using MSTAT software packages and mean differences for each character were compared by Least Significant Difference (LSD) test. Economic analysis was also done. The highest fruit yield (35.89 t/ha) was recorded in T_3 (T_1+ 50% of NPK) followed by that in T_2 (T_1+25% NPK+ 3 t/ha poultry manure) and the lowest (31.11 t ha^{-1}) in T_5 (T_1+ 3 tha^{-1} poultry manure) treatment. The highest gross return (Tk. 287120 /ha) and gross margin (Tk. 194530/ ha) was obtained from T_3 (T_1+50% of NPK) and the lowest gross return (Tk. 248880/ha) and gross margin (Tk. 157340 /ha) were obtained from the treatment T_5 (T_1 +3 t/ha poultry manure) treatment. The highest BCR (3.10) was also obtained from the treatment of T_3 (T_1+50% of NPK). Result revealed that fertilizer dose T_3 = T_1+50% of NPK and T_4 = T_1+25% of NPK 3t/ha poultry would be economic for obtaining higher fruit yield of Bt. Brinjal.

Effect of seedling age on grain yield of transplanting hybrid maize under different tillage conditions in southern region of Bangladesh

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during Rabi seasons of 2015-16 and 2016-17 to find out the proper seedling age for transplanting of hybrid maize (var. Hybrid maize-9) under different tillage conditions. The treatments of the experiment were of two factors viz., Factor A: Tillage condition: 2 (CT = Conventional tillage and ZT = Zero tillage); Factor B: Seedling age of hybrid maize: 5 (i. Transplant of 7-Day old seedling, ii. 14-Day old seedling, iii. 21-day old seedling, iv. 28-Day old seedling and v. Direct seeding). The experiment was laid out in split plot design with three replications. Tillage condition was assigned in the main plots and the seedling age in the sub-plots. The unit plot size was 3 m × 2.4 m. The variety of hybrid maize was BARI Hybrid Bhutta-9. Seeds/seedlings of maize were sown/transplanted on 28 December 2015 (1^{st} year) and 8 January 2017 (2^{nd} year). Earlier, seedlings of different ages (7-day old, 14-day, 21-day and 28-day old) were raised in the nursery bed accordingly. The plant spacing was row to row distance 60 cm and plant to plant distance was 25 cm. Fertilizers were applied in the experiment field at the rate of 255-75-80-52-5-2.0-1.5 kg/ha of N-P-K-S-Mg-Zn-B, respectively along with 6 t/ha cowdung (FRG, 2012). One-third N and all other fertilizers were applied as basal dose during final land preparation. The rest N was applied as top dressing in two equal splits after 1^{st} and at 2^{nd} irrigation i.e. at 20-25 DAP and at 35-40 DAP, respectively. Irrigation was applied for three times and other intercultural operations were done as when necessary. Data were analyzed statistically and the mean differences were adjudged with Duncan's Multiple Range Test (DMRT). The highest yield of grain was recorded in conventional tillage (8.49 t/ha) but the lower yield (8.21 t/ha) was found in zero tillage condition. The seedling age had significant effect on the yield attributes and grain yield. Field duration became the longest (118.83 days) in direct seeding followed by 7-day old seedling (105.33 days) but the duration for 14-day, 21-day and 28-day old seedlings were 100, 91and 84 days, respectively. Transplanting of 7-day old seedling produced the highest yield of grain (9.32 t/ha) followed by 14-day old seedling (9.10 t/ha). Besides, direct seeding and 21-day old seedling gave the yields of 7.89 and 8.19 t/ha, respectively, while the 28-day old seedling gave the lowest yield (7.25 t/ha). The interactions of tillage condition and seedling age had no significant effect on the studied plant characters except the plant height and stover yield. The stover yield decreased drastically with the increasing of seedling age of maize. Economic analyses showed that 14-Day old seedling with conventional tillage gave the highest gross margin (Tk. 81981 t/ha) and BCR (2.26). The result revealed that transplanting of 7 to 14 day old seedlings under conventional or zero tillage condition can be practiced for sustaining the yield and profitability of hybrid maize in southern region of Bangladesh.

Effect of different management practices on the yield of sunflower varieties in southern region

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during Rabi season of 2016-17 to observe the yield of sunflower varieties under different management practices. The treatments of the experiment were of two factors viz., Factor A: Two sunflower varieties viz., V_1 = BARI Surjomukhi-2 (open pollinated variety), and V_2 = Hisun-33 (hybrid variety); Factor B. Three management practices, viz., M_1 = High management (Recommended fertilizer-RF: 90-35-80-30-3-2 kg/ha of N-P-K-S-Zn-B, respectively) + Cowdung (CD) 8 t/ha + 3 Irrigations (30 DAS + 50 DAS + 70 DAS) + 2 Weedings, M_2 = Moderate management (75%RF + CD 5 t/ha+ 2 Irrigations (30 DAS+ 50 DAS) + 1 weeding), and M_3 = Farmers' practice (50-20-40 kg/ha of N-P-K, respectively) + 1 Irrigations (50 DAS) + 1 Weeding). The experiment was laid out in split plot design with three replications, where variety was assigned in main plots and management practices were placed in the sub-plots. The unit plot size was 4 m x 3 m. The row to row distance was 50 cm and maintaining plant spacing 25cm. The experiment plots were fertilized properly following the treatment specifications under this experiment. Half of urea and all of triple super phosphate, muriate of potash, gypsum, zinc sulphate, boric acid, and cowdung were applied as basal during final land preparation. Remaining half amount of urea was applied as side dress in two equal splits at 20-25 days after sowing (DAS) and 40-45 DAS (before flower initiation stage) and mixed thoroughly. Seeds were sown on 4 December 2016. Crop was harvested after attaining the physiological maturity of the varieties. Significant variations were observed between the varieties regarding plant population/plot, plant height, filled grain/head, grain weight/head, grain weight/plot and grain yield. The seed yield was the highest in Hisun-33 (3.22 t/ha). The management practices had also significant effects on plant height, head diameter, filled grain/head, grain weight/head and grain yield. High management practice produced the highest seed yield (3.38 t/ha). The highest grain yield (4.15 t/ha) was recorded in high management (Recommended fertilizer: 90-35-80-30-3-2 kg/ha of N-P-K-S-Zn-B, respectively + Cowdung 8 t/ha + 3 Irrigations at 30 DAS, 50 DAS and 70 DAS + 2 Weedings) with Hisun-33.

Effect of tillage and planting method on the performance of sunflower

The experiment was carried out at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during Rabi season of 2016-17 to find out the appropriate planting technique(s) for increasing the yield of sunflower (var. BARI Surjomukhi-2) in southern region of Bangladesh. The treatments of the experiment were two tillage options (T_1 = Zero tillage, and T_2 = Conventional tillage), and three planting system (A_1 = Dibbling, A_2 = Broadcasting, and A_3 = Line sowing in furrow) were used in this study. The experiment was laid out in split plot design with three replications. Unit plot size was 3 m × 4 m. Plant spacing for line sowing was 60 cm × 25 cm. Seeds of sunflower were sown on 7 December 2016 as per treatment. In case of zero tillage, broadcasting of seed was done under proper moist condition of the soil. The experimental plots were fertilized with 90-35-75-30-4-1.5 kg/ha of N-P-K-S-Zn-B, respectively (FRG, 2012) before seed sown. Half of urea and all other fertilizers were applied as basal dose during final land preparation. The rest N was applied as top dressing in 2 equal splits at 20-25 days after emergence and before flowering. The crop was harvested on 10 March 2017. Results showed that tillage options had significant effect only on the grain yield. Conventional tillage gave the higher yield (2.78 t/ha) followed by zero tillage (2.44 t/ha). The highest diameter, number of filled grain/head and grain weight/head were recorded in dibbling method . But plant population was the highest in line sowing. The highest yield of grain (3.1 t/ha) was obtained from dibbling method followed by broadcasting (2.6 t/ha) and the lowest yield (2.08 t/ha) was found in line sowing. Conventional tillage along with dibbling method produced the highest yield (3.3 t/ha). Yield was also highest in the interaction of conventional tillage × broadcasting method (3.27 t/ha).

Effect of different tillage and fertilization method on maize

The experiment was conducted at Regional Agricultural Research Station, Jessore during *rabi* seasons of 2015-16 and 2016-17 to evaluate the effect of tillage and fertilization method on yield performance of maize (var. BARI Hybrid Bhutta-9) under CA systems. The experiment was designed with five tillage and fertilization methods viz. T_1=Dibbling planting and dibble fertilization (MG of NPK), T_2= Strip till machine seeding and dibble fertilization (MG of NPK), T_3= Strip till machine Seeding and fertilization (G of NPK), T_4= Strip till machine seeding and fertilization before stripping (G of NPK) and T_5= Conventional practice. The experiment was laid out in a randomized complete block (RCB) design with three replications having 6 m × 5 m plot size. The soils were well drained with silty clay loam in texture having pH of 8.5. The results indicate that grain yield was not significantly influenced by tillage and fertilization method. However, highest grain yield (8.4 t/ha) was obtained from conventional practice. The highest gross Margin (Tk 11,825/ha) was recorded from strip till machine seeding and dibble fertilization method which was followed by strip till machine seeding and fertilization method (Tk 8, 325/ha).

Weed management

Effect of different herbicides for controlling weeds in maize field

A field experiment was conducted at Agronomy research field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during the period from November 2016 to April 2017 to select suitable herbicide for controlling weed in maize field. The treatments were: T_1 = Dara 15 EC @ 2 L/ha spraying after emergence of weed, T_2 =Aneha 27.5 SC @ 2 ml/L spraying after emergence of weed, T_3 = calaris Xtra 27.5 SC @ 3L/ha spraying after emergence of weed, T_4 = ZURA 72 SL @ 1.5L/ha spraying after emergence of weed, T_5 = Two hand weeding at 20 & 40 DAE and T_6 = control (no weeding or herbicide). The trial was set up in randomized complete block design with three replications. The unit plot size was 5 m × 4.5 m. Test crop variety was Miracle. The crop was fertilized with cowdung 5 t/ha, 250-55-110-40-5-1.5 kg/ha of N P K S Zn B, respectively. One third of urea and all other fertilizers were applied during final land preparation. Remaining 2/3 urea were top-dressed in two equal splits at 30 and 60 DAE followed by irrigation. A light irrigation was given after sowing for uniform emergence of seeds. Seeds were sown on 20 November 2016. Weed samples were collected using 50 cm × 50 cm quadrat from randomly selected four places from each plot at 25 and 50 days after emergence. Number and dry weight of weeds were recorded carefully. Weed control efficiency (WCE) was calculated. The crop was harvested on 13 April 2016. The highest weed population (107 and 178 weeds/m^2) was recorded in control plot at 25 and 50 DAE, respectively. The lowest (33 and 89 weed/m^2) were recorded in T_5 treatment. The highest WCE (weed control efficiency) of 80% and 81% was found in T_3 treatment at 25 and 50 DAE, respectively followed by T_5 treatment. The highest seeds/cob (622) and yield (10.88 t/ha) was obtained from T_3 treatment. The result revealed that spraying of herbicide calaris Xtra 27.5SC (@ 3 liter/ha) at 25 DAE would be the most effective to control weeds for obtaining higher yield of maize.

Effect of different herbicides on weed control in onion field

A field experiment was conducted at Agronomy research field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during the period from November 2016 to April, 2017 to find out the appropriate herbicide for controlling weed in onion field. The treatments were: T_1 = Bentazone 48% @ 3 L /ha spraying before transplanting of onion, T_2 = Super 30 WP @ 1.5 g/ 10 L of water after emergence of weed, T_3 = FARMPROP 9 EC@ 0.75 ml/L water spraying after emergence of weed, T_4 = Red super 90 EC @ 650 ml/ha spraying after emergence of weed, T_5 = Two hand weeding at 20-25 and 35-40 DAE and T_6 = control (no herbicide or hand weeding). The trial was set up in randomized complete block design with three replications. The unit plot size was 4.8 m × 4 m. The crop was fertilized with cowdung 5 t/ha and 120-39-75-20 kg/ha of NPKS, respectively. Cowdung was applied at the time of land preparation. Half of N,K and full dose of P, S were applied at the time of final land preparation and remaining N and K were applied as top dressed at 25 and 50 days after transplanting followed by irrigation. Seedlings of onion variety (BARI Piaj-1) were transplanted on 25 November 2016. A light irrigation was given after transplanting. Weed samples were collected from randomly selected four places by using 50 cm × 50 cm quadrat from each plot at 25 DAE, 50 DAE and at harvest. Number and dry weight of weeds were recorded carefully. The crop was harvested on 25 March, 2017. Yield and yield contributing characters were recorded and analyzed statistically. Means was adjusted by LSD test at 5% level of significance. The highest weed population 46, 98 and 120 (weeds/m^2) were recorded in control plot at 25, 50 DAE and at harvest respectively. The lowest weed population 32, 38 and 100 weeds/m^2 was recorded in T_5 treatment at 25, 50 and at harvest, respectively. The highest WCE (weed control efficiency) 17%, 60 % and 54% was found in T_5 treatment at 25, 50 DAE and at harvest, respectively followed by T_2 treatment. The highest single bulb weight (47.15 g) and yield (7.84 t/ha) was obtained from T_5 treatment which was at par with T_2 treatment. The result revealed that two hand weeding at 20-25 and 35-40 DAE would be the best option for getting maximum yield of onion. But for herbicidal weed control, spraying of Super 30 WP (@ 1.5 g/ 10 liter of water) 25 DAE might be suitable weed management option for obtaining higher yield in onion.

Effect of duration of weed competition on the yield of maize in *kharif* season

A field experiment was conducted at the research farm of Bangladesh Agricultural Research Institute, Joydebpur, during kharif season of 2016 to find out the critical period of maize-weed competition. The experiment was consisted of 12 treatments viz; no weeding (T_1), no weeding up to 50 DAE (T_2), no weeding up to 40 DAE (T_3), no weeding up to 30 DAE (T_4), no weeding up to 20 DAE (T_5), no weeding up to 10 DAE (T_6), weeding up to 50 DAE by 3 times (T_7), weeding up to 40 DAE (T_8), weeding up to 30 DAE (T_9), weeding up to 20 DAE (T_{10}), weeding up to 10 DAE (T_{11}) and weed free by 4 times weeding (T_{12}). The experiment was laid out in RCB design with three replications. The unit plot size was 4.2m x 3.0m. The crop was fertilized with 200, 60, 100, 42 kg/ha of N,P,K,S (FRG, 2012), respectively. One third nitrogen and other nutrients was applied as basal during final land preparation and remaining nitrogen was side-dressed in two equal splits in maize rows after respective weeding at 30 and 60 DAE. The test variety was BARI Hybrid Bhutta-9. Maize seeds were sown at 60 cm x 20 cm spacing on 15 March 2016. Three irrigations were applied, one for ensuring emergence, the others at 30 and 60 DAE. The crop was harvested on 02 July 2016. The weed species *Echnochloa crusgalli, Digitaria sanguinalis Alternanthera philoxeroides* were found as most dominant species with summed dominance ratio of 19.48, 21.58 and 23.28, respectively. Among the weed groups, grasses was found dominant than others. The SDR values of grasses, broad leaves and sedges were 64.39, 29.46 and 6.15, respectively. No weeding condition upto 10 DAE and 50 DAE produced weed dry matter 331 g/m^2 and 835 g/m^2, respectively. Weed free throughout the growing period produced 258 g/m^2 weed dry matter. Weedy environment upto 20 and weeding upto 20 DAE produced identical yield of 7.18 and 7.20 t/ha, respectively. On the contrary, weedy environment upto 30 DAE produced significantly lower grain yields. Therefore, it indicated that critical period of maize-weed competition in kharif season lies between 20 to 30 DAE of maize growth stage.

Effect of duration of weed competition on the yield of maize in *Rabi* season

A field experiment was conducted at the research farm of Bangladesh Agricultural Research Institute, Joydebpur, during Rabi season of 2016-2017 to find out the critical period of maize-weed competition. The experiment was consisted of 14 treatments viz; no weeding (T_1), no weeding up to 60 DAE (T_2), no weeding up to 50 DAE (T_3), no weeding up to 40 DAE (T_4), no weeding up to 30 DAE (T_5), no weeding up to 20 DAE (T_6), no weeding up to 10 DAE (T_7), weeding up to 60 DAE by 3 times (T_8), weeding up to 50 DAE (T_9), weeding up to 40 DAE (T_{10}), weeding up to 30 DAE (T_{11}), weeding up to 20 DAE (T_{12}), weeding up to 10 DAE (T_{13}) and weed free by 4 times weeding (T_{14}). The experiment was laid out in RCB design with three replications. The unit plot size was 4.2 m x 3.0 m. The crop was fertilized with 250, 75, 120, 52 kg/ha of N,P,K,S (FRG, 2012), respectively. One third nitrogen and other nutrients was applied as basal during final land preparation and remaining nitrogen was side-dressed in two equal splits in maize rows after respective weeding at 30 and 60 DAE. The test variety was BARI Hybrid Bhutta-9. Maize seeds were sown at 60 cm x 20 cm spacing on 30 November 2016. Three irrigations were applied, one for ensuring emergence, the others at 30 and 60 DAE. The crop was harvested on 18 April 2017. Data on weed species, weed density and weed biomass at were taken upto 60 DAE. Plant data on grains/cob, 100-grain weight and grain yield were recorded. The weed species *Echnochloa crusgalli, Digitaria sanguinalis* and *Alternanthera* *philoxeroides* were found as most dominant with summed dominance ratio of 35.61, 18.28 and 14.96, respectively. No weeding condition upto 10 DAE and 60 DAE produced weed dry matter 90.88 g/m^2 and 426.97 g/m^2, respectively. Weed free throughout the growing period produced 101 g/m^2 weed dry matter. The higest weeds canopy coverage of 74.8% was observed in no weeding treatment (T_1), which was followed by weeding upto 10 DAE (51.84%). Weeds canopy coverage reduced with duration of weeding period. For weeding upto 20, 30, 40, 50 and 60 DAE, the weeds canopy coverages were observed 33.82, 29.25, 16.94, 7.36 and 4.94%, respectively. The lowest weeds canopy coverage was recorded 4.14% in weed free treatment.Weedy environment upto 20 and 30 DAE produced identical yield of 8.54 and 8.22 t/ha, respectively. On the contrary, grain yield of 7.96 t/ha obtained from weedy environment upto 40 DAE was significantly lowered than weedy upto 30 DAE. Therefore, it indicated that critical period of maize-weed competition lies between 30 to 40 DAE of maize at vegetative growth and weedy environment from10 to 40 DAE was more sensitive than other growth stage.

Herbicidal weed control in sweet gourd

A field experiment was conducted at the research farm of Bangladesh Agricultural Research Institute, Joydebpur, during *rabi* season (December to March) of 2016-2017. The soil was silty clay loam with pH 6.3 belonging to eco-logical zone-28. The experiment was consisted of seven treatments viz; Pre-sowing herbicide application (7 days before plenting)=(T_1), post-emergence herbicide application (20 days after emergence)=(T_2), Post-emergence herbicide application (40 days after emergence)= T_3, Post-emergence herbicide application (20 DAE + 40 DAE)= T_4, One hand weeding at 30 DAE=T_5, Weed free= T_6, control (No weeding)= T_7. The experiment laid out in RCBD design with three replications. The unit plot size was 4m×4m. The crop was fertilized with 75, 36, 60, 21, 2, 1.4 kg/ha of N, P, K, S, Zn and B (FRG, 2012), respectively. All of organic manure, P, K, S, Zn and B were applied in pit 5-7 days before planting and mixed thoroughly with the soil. N was applied around the plant as side dressing at 15, 35, 55 and 75 days after planting under moist soil condition and mixed thoroughly with the soil as soon as possible for better utilization. The test variety was BARI sweetgourd-2. Sweet gourd plant were transplanted at 2 m × 2 m spacing on 1 December 2016. Six times of irrigations were applied in field. The crop was harvested on 06 to 20 march 2017 at three times. *Cypreus rotundus* (Mutha), *Enhaydra fluatuans* (Helencha), *Paspalum commergonii* (Gaicha), *Heliotropium indicum* (Hatishur) were found as dominant weed species in the experiment field. Among all the treatments, the highest efficiency of weed control by hand weeding (61% at 40 DAE and 96% at 80 DAE) was found in weed free treatment. Hand weeding produced the highest fruit yield (32.03 t/ha) and post-emergence herbicide application (Panida–weed control efficiency 90%) at 20 DAE+40 DAE treatment gave higher fruit yield (31.01 t/ ha) among the herbicide in sweet gourd field.

Weed control methods in sesame

The experiment was conducted at the RARS, Ishurdi, Pabna and RARS, Jamalpur during Kharif season of 2016 to find out the suitable weeding methods for controlling weeds in sesame for maximum return. Six weeding methods were included in the experiment viz., $T_{1=}$ Pre-emergence of weeding (herbicide affinity), $T_{2=}$Pre-emergence + one hand weeding at 20 DAE, T_3= One weeding at 20 DAE, T_4= Two weeding at 20 and 40 DAE and T_5= Control. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 3m × 3m. The crop was sown on 10 April 2016 at Ishurdi and 10 February, 2016 at Jamalpur and harvested on 11 July 2016 at Ishurdi and 12 May 2016 at Jamalpur. Fertilizer was applied @ 58-30-25-20-2-1 kg/ha of N-P-K-S-Zn-B, respectively, (FRG 2012) in the form of urea, triple superphosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively, in both locations. Half of N and all other fertilizers were applied at final land preparation. Remaining N was applied as top dressed at 25 DAE in both locations. Herbicides were applied at moist condition of soil after irrigation. Weed sample were collected from 1 m^2 per plot at 30 DAS and oven dried up to a constant weight at 75°C. The oven dried weight of weeds was recorded. Weed control efficiency (WCE) was worked out by using the formula (Mani *et al.*, 1973). Weed control efficiency of affinity at Ishurdi 64% and Jamalpur 71%.

$$\text{WCE (\%)} = \frac{\text{Dry weight of weeds in unweeded control - dry weight of treatment}}{\text{Dry weight of weeds in unweeded control}} \times 100$$

Economic analysis was performed in both locations. From the results revealed that the treatment of pre-emergence + one hand weeding at 20 DAE and two weeding at 20 and 40 DAE (T_4) gave the higher yield but on the basis of economic point of view, application of herbicides (affinity) in pre-emergence condition was profitable at Ishurdi and pre-emergence + one hand weeding at 20 DAE (T_2) was profitable at Jamalpur.

Effect of herbicides on weed density and yield of lentil

A field experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during 2016-17 to find out the suitable herbicide to control weed in lentil field. Eleven treatments viz. T_1= Gramoxon, T_2= Jahoma, T_3= Lonstar, T_4= Panida, T_5= Joju, T_6=Whipsupr, T_7= Sunrise, T_8= Fielder, T_9= Comit, T_{10}= Hand weeding and T_{11}= Control (No weeding) were included in the experiment. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 2 m x 2.5 m. Seeds of BARI Masur-7 (@ 35 kg/ha) were sown on 24 November, 2016 and harvested at 2 March, 2017. Six herbicides were applied at moist condition of soil after irrigation for proper seed germination (means pre-emergence condition). Six herbicides were applied in post emergence at 20 days after emergence. The experimental plot was fertilized with @18-24-30-18-2.0-1 N-P-K-S-Zn and B kg/ha during final land preparation (FRG-2012). Weed samples were collected 1 m^2 per each plot at 25 DAS and weed dry matter was taken after oven dry. Among the herbicides, Whipsuper was effective for controlling weeds (efficiency 63%) as well as achieving higher yield and economically profitable in pre-emergence and post emergence application of herbicides. Although, hand weeding produced the highest seed yield (2.23 t/ha), it was not profitable due to high cost of labour for weeding.

Multiple Cropping

Fertilizer management in hybrid maize-squash intercropping systems

An intercropping experiment was carried out at BARI farm, Gazipur during *rabi* season of 2016-17 to determine optimum fertilizer dose for hybrid maize-squash intercropping system. Five fertilizer packages i) 250-75-120, 50-4-2 kg/ha of NPKSZnB ii) 275-85-135-55-5-2 kg/ha of NPKSZnB iii) 300-95-150-60-6-2 kg/ha of NPKSZnB iv)325-105-165-65-7-2 kg/ha of NPKSZnB and v)350-115-180-70-8-2 kg/ha of NPKSZnB were used in hybrid maize-squash intercropping system. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4.5 m x 4.0 m. The hybrid maize (var. BARI Hybrid Bhutta-9) and squash were used in this intercropping experiment. Seeds of maize and squash were sown/ on November 19, 2016 according to treatments. The full amount of P, K, S,Zn, B and $^1/_3$ N were applied as basal in the form of triple super phosphate, muriate of potash, gypsum, zinc sulphate, boric acid and urea, respectively. The remaining N was top dressed in two equal splits at 30 and 60 days after sowing (DAS) in between maize rows. A light irrigation was given after sowing for proper establishment of crops. Subsequently three irrigations were applied at 30, 60 and 90 DAS. Two hand weeding were done at 20 and 40 DAS to keep the crops reasonably weed free. Yield components of maize and squash were taken from randomly selected 10 plants from each plot. Maize was harvested at 145 DAS and squash at 55 DAS. The highest squash yield (18.38 t/ha) was obtained with N_{300} P_{95} K_{150} S_{60} Zn_6 B_2 Kg/ha.The highest yield of maize was recorded from maize paired row + two rows squash with N_{350} P_{115} K_{180} S_{70} Zn_8 B_2 Kg/ha. This combinations also gave the highest maize equivalent yield (23.9 t/ha), gross return (TK.286800/ha) and benefit cost ratio (2.84). The results revealed that maize paired row +2 rows squash with N_{300} P_{95} K_{150} S_{60} Zn_6 B_2 Kg/ha might be economically profitable for maize-squash intercropping system.

Intercropping indian spinach with hybrid maize under different planting systems

A field experiment was undertaken at Joydebpur, RARS, Jessore and RARS, Ishurdi of Bangladesh Agricultural Research Institute during Kharif -1 season of 2016 to find out suitable combination of hybrid maize and Indian spinach intercropping system for higher productivity and monetary advantage. Treatments included in the experiment were: T_1 = Hybrid maize normal row (75 cm × 20 cm) + 1 row Indian spinach (plant to plant 25 cm), T_2 = Hybrid maize paired row (37.5 cm/150 cm × 25 cm) + 1 row Indian spinach (plant to plant 25 cm), T_3 = Hybrid maize paired row (37.5 cm/150 cm × 20 cm) + 2 rows Indian spinach (plant to plant 25 cm), T_4 = Hybrid maize paired row (37.5 cm/150 cm × 20 cm) + 3 rows Indian spinach (plant to plant 25 cm), T_5 = Sole maize (60 cm × 20 cm) and T_6 = Sole Indian spinach (40 cm × 25 cm). The experiment was laid out in randomized complete block design with three replications and the unit plot size was 6m × 5m. Hybrid maize cv. BARI Hybrid Bhutta-9 was used in all locations and Indian spinach cv. BARI Indian Spinach-2 at Joydebpur and Ishurdi but local Indian spinach was used at Jessore. Hybrid maize seeds were sown on 12 March, 2016 and Indian spinach seedlings (25 days old) were transplanted on 10 March, 2016 at Joydebpur, at Jessore hybrid maize seeds were sown on 11 April, 2016 and Indian spinach seedlings (20-25 days old) were transplanted on 9 April, 2016. But at Ishurdi, maize seeds were sown and Indian spinach seedlings were transplanted on the same day (23 March, 2016). The seeds of BARI Hybrid Maize-9 were treated with provex at the rate of 3 g per one kg of seed in all locations. Fertilizers were applied at the rate of 250-76-121-72-5-1 kg ha^{-1} of N, P, K, S, Zn, B (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid for sole maize and intercrop. One third of N, whole amount of TSP, MoP, gypsum, zinc sulphate and boric acid were applied as basal. Remaining 2/3 N was top dressed at 20 and 40 days after sowing (DAS) of maize. In intercrop, extra N (40 kg/ ha) was applied in 2 splits at 20 and 40 DAT as ring method to Indian spinach. Sole Indian spinach was fertilized at the rate of 70-15-45-15 kg ha^{-1} of N, P, K and S. One third of N and all other fertilizers were applied as basal. Rest N was applied in 2 splits at 20 and 40 DAT as ring method in all locations. Indian spinach was harvested 6 times at Joydebpur and three times at Jessore and Ishurdi. In all locations, maize equivalent yield was computed. Light availability was measured by PAR Ceptometer (Model – LP-80, Accu PAR, Decagon, USA) in only Joydebpur location. Grain yield of maize was the maximum in sole crop but it was decreased 9.5-17.9 % at Joydebpur, 7.7- 17.1 % at Jessore and 13.8-35.3 % at Ishurdi due to intercropping. All intercropping treatments showed better performance than sole maize crop. The highest maize equivalent yield (17.90 t/ ha at Joydebpur, 8.92 t /ha at Jessore and 10.23 t/ha at Ishurdi), gross return (Tk. 268450 ha^{-1} at Joydebpur, Tk. 133750 /ha at Jessore and Tk. 153500 /ha at Ishurdi), gross margin (Tk. 178450 / ha at Joydebpur, Tk. 45380 /ha at Jessore and Tk. 73500 /ha at Ishurdi) and benefit cost ratio (2.98 at Joydebpur, 1.51 at Jessore and 1.92 at Ishurdi) were observed in hybrid maize paired row + 3 rows Indian spinach. The highest Land equivalent ratio (1.41 at Joydebpur, 1.23 at Jessore and 1.22 at Ishurdi) was also found in the same treatment. The results revealed that hybrid maize paired row + 3 rows Indian spinach might be economically profitable for hybrid maize + Indian spinach intercropping system at Joydebpur, Jessore and Ishurdi regions.

Intercropping cabbage with sweet gourd at different cabbage planting geometry

The experiment was conducted at the research field of Agronomy Division, BARI, Joydebpur and ARS, Rajbari during rabi season of 2016-17 to find out appropriate planting geometry of cabbage (var. BARI Badhacopy-1) for intercropping with sweet gourd (var. BARI Mistikumra-2) having minimum crop competition. Different intercropping treatments viz. T_2=100% sweet gourd (2 m × 2 m) + 100% cabbage (50 cm × 50 cm), T_3 =100% sweet gourd (2 m × 2 m) + 62.5% cabbage (50 cm ×80 cm), T_4 =100% sweet gourd (2 m × 2 m) + 50% cabbage (50 cm x 100 cm), T_5 =100% sweet gourd (2 m × 2 m) + 39% cabbage (80 cm × 80 cm), T_6 =100% sweet gourd (2 m × 2 m) + 31% cabbage (80 cm × 100 cm) were compared with T_1 = sole sweet gourd (2 m × 2 m) and T_7 = sole cabbage (50cm × 50cm). T_7 treatment was absent Rajbari. The experiment was laid out in a RCB design with 3 replications. BARI Mistikumra-2 and BARI Badhacopy-1 were used in this experiment. Twenty five days old seedlings of cabbage were transplanted on 25 November 2016 at Joydebpur and on 12 November 2016 at Rajbari. Thirty days old seedlings of sweet gourd were transplanted on 10 December 2016 at Joydebpur and on 27 November 2016 at Rajbari. Fertilizers @ 80-36-100-24-2-2 kg/ha NPKSZnB+ CD: 5 t/ha were applied in sole sweet gourd. Fertilizers @ 100-50.5-90.5-18-2.3 kg/ha NPKSZnB+ CD: 5 t/ha were applied in sole cabbage and intercrop combination. All of organic manure and KSZnB was applied in pit 7 days before transplanting of cabbage and sweet gourd seedlings, while urea and MoP were top dressed in two equal splits at 15 and 35 DAT to winter vegetables. Sweet gourd harvesting was started from 90 DAT and four harvesting was done up to 1-5 April 2017. Cabbage was harvested two times (55 and 70 DAT) at Joydebpur. On the other hand, at Rajbari, sweet gourd harvesting was started from 105 DAT and harvesting was done four times and cabbage was harvested three times (74, 80 and 84 DAT). The results revealed that the highest sweet gourd yield (20.91 t/ha at Joydebpur and 29.49 t/ha at Rajbari) was recorded in sole sweet gourd and the lowest (8.05 t/ha at Joydebpur and 13.39 t/ha at Rajbari) was found in (100% sweet gourd + 100% cabbage. Significantly the highest cabbage yield (55.21 t/ha) was recorded in sole cabbage at Joydebpur, whereas, at Rajbari the highest cabbage yield (76.62 t/ha) was found in 100% sweet gourd + 100% cabbage combination. Maximum sweet gourd equivalent (50.91t/ha) yield was recorded in 100% sweet gourd + 62.5% cabbage combination which was similar to 100% sweet gourd + 50% cabbage combination at Joydebpur. These two treatments produced high gross return (Tk 509113/ha and Tk 504633/ha) and BCR (3.98 and 4.03) at Joydebpur area. At Rajbari, the maximum SEY (90.01 t/ha) was recorded in 100% sweet gourd + 100 % cabbage combination which was followed by 100% sweet gourd + 62.5% cabbage combination. This treatment showed the highest gross return (Tk 450067/ha) and BCR (3.73). The results revealed that 100% sweet gourd (2 m × 2 m) +50 - 62.5% cabbage combination for Joydebpur and 100% sweet gourd (2 m × 2 m) +100 % cabbage for Rajbari would be suitable for total productivity and economic return

Development of five crop-based cropping pattern for increasing cropping intensity and productivity

The experiment was conducted at the research field of Agronomy Division BARI, Joydebpur, Gazipur (AEZ 28), RARS, Jessore (AEZ 11), RARS, Burirhat, RARS, Jamalpur (AEZ- 8) and RARS,Ishurdi during *rabi* season of 2015-16 to increase cropping intensity and productivity in rice based cropping pattern. Six treatments of cropping sequence were as follows: CP_1 = Potato- Mungbean- T.*aus*- T. *aman*, CP_2 = Potato- Spinach/ Red amaranth- Mungbean- T. *aus*- T. *aman*, CP_3 = Mustard- Spinach/ Red amaranth- Mungbean- T. *aus*- T. *aman*, CP_4 = Gardenpea- Boro- T. *aus*- T. *aman*, CP_5 = Gardenpea- Spinach/ Red amaranth- Mungbean- T. *aus*- T. *aman*, CP_6 = Fallow- *Boro*- Fallow- T. *aman* (Farmers practice). The experiment was laid out in a RCB design with 4 replications. The unit plot size was 5 m x 4 m. Recommended doses of fertilizer were used for all crops. Potato tubers (cv. Diamant) were planted with 60 cm x 25 cm spacing on 02 to 03 November, 2015 and harvested on 26 January 03 February, 2016 at different locations. Mustard cv. BARI Sarisha-14 was sown with 30 cm x 5 cm spacing on 28 to 31 October, 2015 and harvested on 11 to 17 January, 2016 at different locations. Gardenpea (BARI Motorshuti-3) was sown with 30 cm x 5 cm spacing on 27 to 31 October, 2015 and harvested on 1 to 3 January, 2016. BARI Spinach-1 was broadcast on 03 to 28 January, 2016 and harvested as vegetable on 08 to 27 February, 2016 at different location. Mungbean seeds (BARI Mung-6) were sown on 15 to 29 February, 2016 and harvested on 03 to 07 May, 2016. *Boro* rice 40-45 days old seedlings of BRRI dhan 28 were transplanted with 20 cm x 15 cm spacing on 22 to 24 January, 2016 in CP_4 and CP_6. and harvested on 26 to 28 April, 2016. T. *aus* rice 23-25 days old seedling of *Parija* was transplanted with 15 cm × 10 cm spacing on 12 to 14 May 2016 during *kharif* season and harvested on 22 to 25 July, 2016. T. *aman* (BINA dhan 7) were transplanted with 20 cm x 15 cm spacing on 30 to 31 July, 2016 and harvested on 19 to 21 October, 2016 at different locations.

The results indicated that cropping sequence CP_2: (Potato- Mungbean- T. *aus*- T. *aman*) followed by CP_5: Gardenpea- Lalshak- Mungbean- T. *Aus*- T. *Aman* might be suitable for getting the highest rice equivalent yield (REY) [CP_2: (29.51 t/ha) and CP_5: (28.22 t/ha)]. The lowest REY (10.06 t/ha) was obtained from the cropping sequence T. *aman* – Fallow – *Boro* – Fallow. Inclusion of Lalshak/spinach during *rabi* season and mungbean during *kharif-I* season in CP_2 and CP_5 increased REY 193 to 181% as compared to farmer's pattern CP_6. The highest gross return (Tk. 7,84,921/ha) was recorded from CP_5 followed by CP_3 (Tk. 6,94,424/ha) and CP_2 (Tk. 6,65,743/ha). The highest gross margin was obtained from CP_5 (Tk. 6,55,547/ha) followed by CP_3 (Tk. 5,71,322/ha) and CP_2 (Tk. 4,68,892/ha). The highest BCR was found in CP_5 (6.07) followed by CP_3 (5.64) and CP_2 (3.38).

Intercropping of potato with maize under different planting system in southern region of Bangladesh

The experiment was carried out at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during the Rabi season of of 2015-16 and 2016-17 *to find out the suitable planting system for increasing the total yield and economic return of the intercropping system of potato with maize. The treatments of the experiment were of two factors viz., Factor A: Planting time: 2 (T_1 = 15 Nov. & T_2 = 30 November 2015); Factor B:* Planting geometry: 4 (G_1 = 1-Row maize (75 × 20 cm) + 1-Row potato; G_2 = 1-Row maize (60 × 20 cm) + 1-Row potato; G_3 = Sole maize (60 × 25 cm) and G_4 = Sole potato (60 × 20 cm)).The experiment was laid out in randomized complete block design (RCB) with three replications. *The variety of hybrid maize was BARI Hybrid Bhutta-9 and potato variety was BARI Alu-7 (Diamant).* The unit plot size was 5 m × 4 m. Fertilizers were applied in the experiment field at the rate of 570-290-300-230-18-6 kg/ha urea, TSP, MP, gypsum, zinc sulphate and boric acid, respectively along with 6 t/ha cowdung (FRG, 2012). Sole potato where planted 15 November gave the highest yield of tuber (22.07 t/ha) followed by 30 November planting (15.36 t/ha). The lowest yield was obtained from 1-row maize (60×20 cm) +1-row potato treatment. Average yield of hybrid maize also showed the highest for sole crop under 30 November sowing date followed by 15 November sowing. In average of 2-year (2015-16 and 2016-17), sole potato planted on 15 November exhibited the highest maize equivalent yield (17.65 t/ha) followed by 1-row maize (60×20 cm) +1-row (G_2) (17.45 t/ha) under same planting date. Besides, 15 November sowing combined with 1-row maize (60×20 cm)+1-row potato(G_2) gave the highest total return (Tk. 267848/ha) and net return (Tk. 179128/ha). Similarly, under 15 November sowing date, G_2 also produced the highest value of BCR (3.02) followed by 1-row maize (75×20 cm) +1-row potato (G_1) (2.88). Finally it may be concluded that 1-row maize (60×20 cm) +1-row potato when sown at 15 November was suitable combination for higher productivity and economic return.

Intercropping of potato with brinjal

A field experiment was conducted at the Regional Agricultural Research Station, Jamalpur during rabi season of 2016-2017 to find out the optimum spacing of potato - brinjal intercropping system for higher economic return. Treatments included in the experiment were: T_1 = Sole potato (50 cm × 20 cm), T_2 = Sole brinjal (100 cm × 75 cm), T_3 = potato (50 cm × 20 cm) + Brinjal (100 cm × 60 cm), T_4 = potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm), T_5 = potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm), T_6 = potato (60 cm × 25 cm) + Brinjal (120 cm × 75 cm). Design of the experiment was RCB with three replications having the unit of plot 3 m × 3.75 m. BARI Alu – 7 (Diamant) and local brinjal were used as a variety in the experiment. Fertilizers were applied for sole potato: N-P-K-S @ 160-100-160-20 kg /ha and sole brinjal: 80-24-60-10-1.0-0.3 kg/ha N-P-K-S-Zn-B of fertilizers in the form of Urea, triple super phosphate, Muriate of potash, Zypsum, Zinc Sulphate and Boric acid respectively (FRG, 2012). For sole potato at the time of final land preparation cow dung @ 10 t/ha was applied. Other fertilizers were applied later. For sole brinjal: Half cowdung was applied during the final land preparation. Remaining cowdung and full phosphorus, sulphur, zinc and boron were applied in three equal splits at 21, 35 and 50 days after transplanting. Potato was sown on November 26, 2016 and brinjal sown on January 26, 2016. One pheromone trap was used for every one decimal land to control of brinjal fruit and shoot borer. Irrigation was applied two times during growing period of potato and brinjal as and when necessary. Potato equivalent yield (PEY) was also calculated. Cultivation of potato with brinjal at potato (60 cm × 25 cm) + brinjal (120 cm × 75 cm) might be agronomically feasible and economically profitable for potato and brinjal intercropping system. Potato (60 cm × 25 cm) + brinjal (120 cm × 75 cm) performed better in respect of gross return, gross margin, BCR and PEY.

Long term effect of maize based cropping pattern on crop productivity and soil health

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2015-16 to find out the crop productivity and the soil nutrient status. It comprised of eight treatments viz; T_1= Potato/maize – T. *aman* (RF), T_2= Potato/maize – T. *aman* (NS), T_3=Maize/mugbean–T.*aman* (with residues &RF), T_4=Maize/mugbean –T.*aman* (with residues &NS), T_5=Maize/mugbean–T.*aman* (no residues &RF), T_6=Maize/mugbean–T.*aman* (no residues &NS), T_7=Maize–Fallow–T.*aman* (RF)), T_8=Maize – Fallow–T. *aman* (NS). The experiment was laid out in a randomized complete block design (factorial) with three replications. The unit plot size was 5m × 6 m. The tuber of potato was planted on 25 November 2015 and the hybrid maize-7 was relayed on 10 January 2016 between two potato rows after 46 days after potato planting maintaining 60 cm × 20 cm spacing both crops. Potato was harvest on 19 February 2016 and maize was harvest on 24 May 2016.The average yields of cropping pattern (T_1) of Potato–Maize–T.*aman* were found 20.55 t\ha, 5.0 t\ha and 5.8 t\ha, respectively. In cropping pattern (T_2) of Potato–Maize–T. *aman* were found 10 t\ha, 5.0 t\ha and 5.8 t\ha, respectively. The third cropping pattern (T_3) of Maize– Mungbean–T. *Aman* had the average yield of 6.67 t\ha, 611 kg/ha and 5.94 t\ha, respectively. The fourth cropping pattern (T_4) of Maize–Mungbean–T.*aman* were given the average yield of 2.67 t/ha, 822 kg/ha and 2.83 t\ha, respectively. The fifth cropping pattern (T_5) of Maize–Mungbean–T. *Aman* had the average yield of 6.17 t/ha, 700 kg/ha and 5.83 t\ha, respectively. The sixth cropping pattern (T_6) of Maize–Mungbean–T. *aman* had the average yield of 2.17 t/ha, 767 kg/ha and 2.21 t/ha, respectively. On the other hand, the farmers practice cropping pattern (T_7) of *Boro*–T. *aman* gave 7.34 and 5.6 t/ha, respectively. Cropping pattern (T_8) of Boro and T. Aman were obtained 2.25 t/ha and 2.38 t/ha yield, respectively.

Observation trial on potato–potato/maize/mungbean–T. aman rice cropping pattern under AEZ- 3

The trail was conducted at RARS, Burirhat farm, Rangpur during of 2015-2016. There were two treatments viz. T_1=Potato–Potato/Maize/Mungbean–T.aman rice (Proposed pattern) and T_2=Potato-Maize-T.aman rice (Farmers' existing pattern). The design followed for the experiment was RCB with three replications. The unit plot size was 6 m × 5 m. The variety of first was potato: BARI Alu-13, Sagita and 747, second potato: Asterix, third crop maize: BARI Hybrid Bhutta–9, forth crop mungbean: BAR Mungbean-6, T. Aman rice: BINA dhan-7. The planting system was line sowing. The fertilizers were applied at rate of 1st potato: 145-16-105-12-1.5-6-1-6000 N P K S Mg Zn B CD, 2nd potato: 145-8-53 kg/ha NPK, Maize: 210-36-75-30-3-3-1 kg/ha of N P K S Mg Zn B, Mungbean: 20-10-5-0-0-0-1.5 kg/ha of N P K S Mg Zn B, T. Aman rice: 85-6-20-8-1-0-0 kg/ha of N P K S Mg Zn B. The application methods were as like- Potato: Half of NK and full dose of other fertilizer as basal. Rests NK was used as top dressed at 30 DAP. Maize: 1/3rd N and full dose of other fertilizer as basal. Rest N was applied as top dressed at 30 and 60 DAS. Mungbean: All fertilizer as basal. T. *aman* rice: 1/3rd N and full dose of other fertilizer as basal. Rest of N was given as top dressed at 30 and 60 DAT. There were differences of yield of crops in cropping patterns. Higher rice equivalent yield (26.08 t/ha), Gross return (Tk.1050400/ha), gross margin (Tk. 803777/ha) and BCR (4.15) was calculated from Potato–Potato/Maize/Mungbean–T. *aman* rice as compared to farmers' existing pattern. On the contrary lower rice equivalent yield (21.58 t/ha), Gross return (Tk. 565000/ha), gross margin (Tk. 409115/ha) and BCR (3.62) was observed in Potato –Maize–T. *aman* rice pattern. The results revealed that five crops based cropping pattern is possible in Rangpur region.

Development of fertilizer packages for five crop based cropping pattern in rice based cropping system

The field experiment was conducted at the Regional Agricultural Research Station, Jessore (AEZ 11) during 2015-2016 and 2016-17 consecutive years. The soil was silky clay loam in texture with pH of 8.3.The eight fertilizer treatments were as follows: T_1 = 100% NPKSZnB (STB), T_2= T_1+ 25% N, T_3= T_1+ 25% NP, T_4= T_1+ 25% NK, T_5= T_1+ 25% PK, T_6= T_1+ 25% PKN, T_7= 75% of T_1 and T_8= Native fertility. This cropping pattern is composed with five crops; namely, T.*aman*–Mustard–Spinach– Mungbean–T. *aus*. The experiment was laid out in a Randomized Complete Block (RCB) design with 3 replications. The unit plot size was 4 m × 3 m. The objectives of this study were i) to develop the fertilizer packages for five crop based cropping pattern, ii) to assess the agronomic performance and iii) to estimate economic return of five crop based cropping pattern in rice based cropping systems. The eight fertilizer treatments were as follows: T_1 = 100% NPKSZnB (STB), T_2= T_1+ 25% N, T_3= T_1+ 25% NP, T_4= T_1+ 25% NK, T_5= T_1+ 25% PK, T_6= T_1+ 25% PKN, T_7= 75% of T_1 and T_8= Native fertility. This cropping pattern is composed of five crops; namely, T. *aman*–Mustard–Spinach–Mungbean–T. *aus*. Rice equivalent yield (REY) was different under different treatments. The highest total REY 24.28 t/ha was recorded from the Treatment T_6. The lowest total REY (11.19 t/ha) was obtained from the native nutrient treatment (T_8). Total REY was increased by 42 %, 48 %, 48 %, 48 %, 49 %, 54 % and 40% as compared to the native nutrient treatment (T_8), respectively. The highest gross margin (Tk 2, 27,158/ha) was recorded from the treatment T_6 and the lowest gross margin (BDT 1, 26, 662 /ha) was obtained the treatment (T_7). The highest marginal benefit cost ratio (MBCR–7.53) was obtained from the treatment T_6 which was followed by the treatment T_5 (6.76) and the treatment T_7 (6.70).

Intercropping of cabbage with maize

The experiment was carried out at the research field of Agricultural Research Station, Rajbari, Dinajpur during rabi season of 2016-2017 to find out suitable crop combination for higher productivity and economic return. Five different treatments were viz. T_1= Sole maize (60cm×20cm), T_2= Maize planting (75cm×25cm) + One row cabbage (50cm×50cm), T_3= Maize paired row (150cm/37.5cm × 25cm) + Two row cabbage (50cm × 50cm), T_4= Maize planting (60cm×20cm) + One row cabbage (60cm×50cm), T_5= Maize paired row (120cm/30cm×20cm) + Two rows cabbage (60cm×50cm). The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 6m × 4m. The land of the experimental plot was prepared with a power tiller by ploughing and cross ploughing followed by laddering and the soil was brought into good tilth. Fertilizers were applied @ 260-72-148-48-4-2 kg ha^{-1} N-P-K-S-Zn-B in the form of Urea-TSP-MP-Gypsum-$ZnSo_4$- Boric acid for both the sole maize and intercrop combinations. One third of urea and full amount of other fertilizers were applied at final land preparation. Remaining urea was applied at 30 and 60 DAS in two equal splits. Maize (BARI hybrid maize 9) and cabbage (BARI Badhacopy-1) were sown on 02 November 2016 and 12 November 2016. Two irrigations were provided after top dressing of urea. Earthing up and other intercultural operations were done when required. Other plant protection measures were taken when required. Cabbage was harvested on January 10, 2017 and the maize on April 10, 2017.

The highest maize yield (9.12 t/ha) was recorded in sole sweet maize. The highest cabbage yield (47.14 t/ha) was recorded in T_4= Maize planting (60cm×20cm)+ one row cabbage (60cm×50cm). The highest maize equivalent yield (24.06 t/ha) was obtained in maize planting (60cm × 20cm) + one row cabbage (T_4). These two treatments (T_4 and T_5) produced high gross return and gross margin and BCR (4.29 and 4.28). Maize (60cm × 20cm) + one row cabbage (T_4) and maize paired row (120/30cm × 20cm) + two row cabbage (T_5) were found suitable for total productivity and economic return of the system.

Unfavourable Eco-System

Development of floating bed cum trellis for pumpkin cultivation under flooded ecosystem

The experiment was carried out during *rabi* season of 2016-17 under pond condition at Regional Agricultural Research Station, Rahmatpur, Barisal to develop floating bed cum trellis for pumpkin cultivation. The treatments were comprised of two factors, where Factor A. Three production systems viz., S_1 = Water hyacinth based floating bed cum trellis, S_2 = Normal land and S_3 = Plastic drum based floating bed cum trellis; and Factor B. Two pumpkin varieties viz., V_1 = Monika (hybrid variety) and V_2 = BARI Mistikumra-2 (open pollinated variety). The experiment was laid out in randomized complete block design with three replications. The Floating Bed cum Trellis (FBT) was constructed with alternate floating bed and trellis. Water hyacinth and topapana were used for making the floating beds. The size of each of the floating bed was 9.15m (30 feet) long and 1.3m wide and 1.2m height. The trellis was made with bamboo, nylon net and dhaincha (Sesbania sp.). In case of normal land, fertilizers were applied as per recommendation of pumpkin (BARI, 2014; FRG, 2012). For plastic drum based floating bed cum trellis, plastic bag filled with growing media (soil: decomposed water hyacinth: coco-dust = 4:1:1 along with required amount of chemical fertilizers) was kept on the floating drum. The pumpkin seeds were primed with canal water on 30 October, 2016 and then seedlings were raised into the topapana made balls/dolla. Two seedlings were grown into a ball. The seedlings were transplanted on 1 November 2016. Plant spacing was 60cm distance from row to row and 110cm from hill to hill distance. In each floating bed, 1 row seedling of hybrid and 1 row seedling of open pollinated varieties were transplanted. Seedlings of pumpkin were transplanted on water hyacinth made floating bed but their growth and development took place on trellis that kept the floating bed free from plant canopy. Therefore, seeds of leafy vegetable crops (batishak, red amaranth and coriander leaf) were sown on three floating beds as intercropping with pumpkin during its transplanting. The experiment plots were fertilized with 65-36-20-7-1-1 g/10m^2 N-P-K-S-Zn-B, respectively. All nutrients (N-P-K-S-Zn-B) were applied as side dressing in six equal splits at 15, 30, 45, 60, 75 and 90 days after planting. The fertilizer nutrients were applied in liquid form (through mixing with water) surrounding the crop plant. Irrigation was applied as per requirement of crop. The batishak, red amaranth and coriander leaf were harvested on 13 December 2016. The number of fruit/plot was found the highest (25.50) in normal land that was at par to that of water hyacinth based floating bed cum trellis system (21.83). Similarly, the normal land gave the highest yield of fruit (29.06 t/ha) followed by water hyacinth based floating bed cum trellis (19.61 t/ha). Water hyacinth based floating bed cum trellis gave comparatively lower yields for Monika (20.30 t/ha) and BARI Mistikumra-2 (18.91 t/ha). Although the cultivation of pumpkin under normal land condition yielded the highest but the system of water hyacinth based floating bed cum trellis gave satisfactory yield under submerged ecosystem. Hybrid variety of pumpkin might be more suitable for cultivation under floating bed cum trellis system due to its early fruit formation and higher yield.

Nutrient management of cucumber on water hyacinth floating bed

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal from August to October 2016 to develop nutrient management practice for cucumber on water hyacinth made floating bed under submerged/flooded ecosystem. The size of the whole bed (block) was 10 meter long, 1.3 meter wide and 1.2 meter high. The entire bed was divided into five sub plots. There were five treatments (rate of fertilizer) in this experiment viz., T_1 = 40-16-32-12-1-0.5 kg/ha N-P-K-S-Zn-B, respectively; T_2 = 75% of T_1; T_3 = 50% of T_1; T_4 = 25% of T_1 and T_5 = Control (farmers' practice). The experiment was laid out in randomized complete block design with three replications. The variety of cucumber was hybrid. The cucumber seedlings were transplanted on floating bed on 12 August 2016. Results showed that T_1 treatment produced the highest yield (52.89 t/ha), which was statistically similar to that of T_2 (52.69 t/ha) and partially identical to T_3 (50.31 t/ha) and T_4 (47.92 t/ha) treatments but the lowest yield (44.37 t/ha) was obtained from T_5 (farmers' practice) treatment. Treatment T_2 (75% of T_1) might be recommended for hybrid cucumber cultivation on floating bed.

Performance of different potato varieties on water hyacinth made floating bed under submerged ecosystem

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barisal during Rabi season of 2016-17 to observe the performances of potato varieties under water hyacinth made floating bed condition under submerged/flooded ecosystem. The potato varieties were V_1 = BARI Alu-7 (Diamant), V_2 = BARI Alu-8 (Cardinal), V_3 = BARI Alu-13 (Granola). Therefore, the unit plot size was 2m × 1.3m. The experiment was laid out in randomized complete block design with three replications. Seed tubers of the potato varieties were planted on floating bed on 28 November, 2016. The experimental plots were fertilized with 70-15-45-5-3-1-1 g/10m^2 N-P-K-S-Mg-Zn-B, respectively (FRG, 2012). All nutrients were applied as side dressing in four equal splits at 15, 30, 45, 60 days after planting. Crop was harvested on 1 March 2017. The result revealed that tuber weight/plot and tuber yield were significantly differed due to varieties. Maximum tuber weight/hill (375.10g) and tuber weight/plot (15.00 kg) were recorded in BARI Alu-8 followed by BARI Alu-13 (309.55g and 12.38kg, respectively). Among the varieties, BARI Alu-8 (Cardinal) gave the highest yield of tuber (45.44 t/ha) followed by BARI Alu-13 (Granola) (37.50 t/ha). The lowest yield (35.54 t/ha) was obtained from BARI Alu-7 (Diamant). Although BARI Alu-8 (Cardinal) performed better on floating bed.

Performance of different potato varieties grown with decomposed water hyacinth on sorjan bed

The field experiment was implemented at Mugarjhor village, Nazirpur, Pirojpur during Rabi seasons of 2015-16 and 2016-17. The treatments were three potato varieties viz., BARI Alu-7 (Diamant), BARI Alu-8 (Cardinal) and BARI Alu-13 (Granola). The experiment was laid out in randomized complete block design with three dispersed replications. The unit plot size was 5m × 1.5m. After monsoon season, the decomposed materials (water hyacinth, topapana, dulalilata etc.) floating bed were put on the nearby sorjan beds with 25-30 cm thickness. The whole *sorjan* bed was then splited into three plots, where three potato varieties were grown. Seed tubers were planted on 8 and 10 December in 2015 and 2016, respectively with spacing of row to row distance 60 cm and plant to plant 25 cm. Seeds were placed into 5-6 cm depth. Potato crop was harvested on 8 and 10 February in 2016 and 2017, respectively. In 2015-16, potato variety Diamant gave the highest yield of tuber (26.46 t/ha). On the other hand, Granola produced the lowest yield (20.94 t/ha). Similarly, in 2016-17, Diamant produced the highest tuber yield (24.65 t/ha) and the lowest yield (19.06 t/ha) from Granola. The two years (2015-16 and 2016-17) average results exhibited that Diamant gave the highest yield of tuber (25.56 t/ha) followed by Cardinal (22.88 t/ha) and the lowest yield was achieved from Granola (20.00 t/ha). Yield performances of Diamant and Cardinal varieties of potato grown with decomposed water hyacinth on sorjan bed were satisfactory.

Influence of sowing time based temperature on flowering and pod yield of french bean

The experiment was conducted at the research field of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, RARS, Moulvibazar, Sylhet and RARS, Hathazari, Chittagong during rabi season of 2016-2017 to evaluate the flowering behavior and pod yield of French bean. The 12 treatment combinations were studied. The main plot treatments consisted of four sowing dates at 15 days interval starting from 15 November and end of 30 December while sub-plot treatments consisted of three varieties (BARI Jharsheem-1, BARI Jharsheem-2 and BARI Jharsheem-3) were replicated thrice. The experiment was laid out in a split plot design. Crop growth duration was recorded maximum in BARI Jharsheem -2 sown on 30 November (69 days) followed by 15 December sowing (61 days). The minimum duration (51 days) was recorded in BARI Jharsheem-3 at 30 December sowing. Flowering duration of 30 November sowing was longer (18-23 days). Minimum flowering duration was recorded in 30 December sown crop (9-13 days). November sowing performed better in relation to yield components and yield than other sowing. BARI Jharsheem-1 produced the highest pod yield (14.72 t/ ha at Joydebpur and 13.51 t/ha at Moulvibazar) in 30 November sowing. The lowest pod yield (7.14 t/ha) was obtained from 30 December sowing from BARI Jharsheem-2 at Joydebpur. At Moulvibazar the lowest pod yield (2.44 t/ha) was recorded in 30 December sowing from BARI Jharsheem-3. At Hathazari, significantly the highest pod yield was recorded in November sowing from BARI Jharsheem-3 and the lowest one recorded in BARI Jharsheem-2. The results revealed that November would be the optimum sowing time for maximum pod yield of BARI Jharsheem-1 at Joydebpur and Moulvibazar and BARI Jharsheem-3 for Hathazari regions.

Effect of delayed sowing and management practices on phenology, growth and yield of garden pea

The experiment was conducted at the research field of the Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur and RARS, Burirhat, Rangpur during two successive *rabi* seasons of (2015-17) to find out the relation between different development events of garden pea crop and the sowing time based temperature and also to minimize the yield reduction by management practices. The treatments comprised with three sowing dates (30 Nov., 15 Dec. and 30 Dec.) and three management practices (low, medium and high). The experiment was laid out in a split-plot design with three replications. The sowing dates were assigned in the main plots and management practices were arranged in sub-plots. BARI Motorshuti-3 was used as test crop. In case of low management, all fertilizers were applied at the time of final land preparation. Insecticide was sprayed in the respective treatment plots. Under high management, Nov. 30 sowing took maximum days (58 days) to reach harvesting maturity and the Dec. 30 sowing took the minimum days (51days). Late sowing took minimum time from flowering to fresh pod maturity (22 days). The results revealed that the highest pod yield (14.77 t/ha in 2015-16 and 13.09 t/ha in 2016-17 at Joydebpur and 9.63 t/ha in 2015-16 and 10.33 t/ha in 2016-17 at Burirhat) was recorded from 30 November sowing with high management practices which was followed by 15 December with high management practices and the lowest pod yield (8.70 t/ha at Joydebpur and 5.00 t/ha at Burirhat) was obtained from 30 December sowing with low management practices in over the years as well as the location also. Yield reduction in late sowing was reduced to some extent by high management practices. Two year results revealed that 30 November sowing with high management practices (extra 20% recommended fertilizer dose, HRC + two irrigation at pre flowering and pod development stage + seed treatment + one weeding at 21 DAE)showed better pod yield than other combinations.

Effect of potassium in saline soil on growth and yield of soybean

A field experiment was conducted at Agricultural Research Station, Benerpota, Satkhira of Bangladesh Agricultural Research Institute during *rabi* season of 2016-2017 to find out the effect of potassium on growth and yield of soybean in saline soil to increase the productivity in coastal zone. The experiment was consisted of six treatments viz., native nutrients i.e. no fertilizer (T_1), recommended fertilizers (RF) – Potassium i.e. inherent K (T_2), two times recommended potassium (RK) + others RF (T_3), two times RK with split application + others RF (T_4), three times recommended potassium (RK) + others RF (T_5), three times RK with split application + others RF (T_6). The soil was non-calcareous Grey Floodplain with silty clay loam in texture belonging to agro-ecological zone 13. The experiment was laid out in RCB design with three replications. The unit plot size was 4.2 m x 3.0 m. The crop was fertilized with 25, 35, 65, 18 kg/ha of N,P,K,S (FRG, 2012), respectively. Half of nitrogen and all other nutrients were applied as basal during final land preparation. Potassium was applied as basal and also splits by following treatments. Rest of nitrogen and potassium were top dressed at flowering stage (35 DAE) followed by irrigation. The test variety was BARI Soybean-6. The seeds were sown on December 07, 2016 with 30 cm apart lines maintaining 5 cm plant to plant distances. The crop was harvested on 29 March 2017. Data on filled pods, 100-seed weight and seed yield were recorded. Soil

EC and rainfall data were also recorded. Collected data were analyzed statistically with MSTAT-C statistical package. The means were separated by least significant difference (LSD) test. Soil salinity levels increased with increased crop duration. Salinity level was 2.01 dS/m at sowing time and at maturity stage it rose 8.97 dS/m. The highest seed yield was recorded 2.01 t/ha in three times recommended potassium application with split. The treatments three and two times recommended potassium with split application increased seed yield of 43.57% and 42.86% over no fertilizer treatment, respectively. Seed yield of soybean increased in saline soil through split application of potassium that improve the ability of the plants to tolerate salinity stress. Salinity stress for soybean might be minimized through split application of potassium (2-3 folds).

Growing of T.*aman* rice during monsoon for timely establishment of succeeding winter crops

The experiment was conducted at farmers' field (2 farmers) at Bandra village in Amtali upazila of Barguna district during monsoon season of 2016 to introduce the short duration modern variety of T.*aman* rice during monsoon for timely establishment of succeeding winter crops. The experimental site belongs to the agro-ecological zone Ganges Tidal Floodplain (AEZ-13). The soil type is medium low land and soil texture is clay loam. The salinity level was very slightly (2.1-4.0 dS/m) during transplanting of monsoon rice. Seedlings of BRRI Dhan62 were transplanted in the main field of Bandra village of Amtali upazila of Barguna district on 28 July 2016. Before transplanting, the experimental fields were prepared with the help of power tiller. The plots were fertilized with 127-52-82-60-10 kg/ha urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate, respectively. Whole amount of TSP, MoP, gypsum and zinc fertilizers were applied during final land preparation. One third urea was applied at basal, 1/3rd at 4-5 tillerings stage and 1/3rd at 5-7 days before panicle initiation (PI) stage. Different intercultural operations were done as per requirement of the crop for obtaining better yield performance. The crop became physiological maturity on 4 October 2016 but it was harvested during 8-10 October 2016. Data were taken carefully on yield components and yield of T.*aman* rice. The average yield of these two farmers was 3.15 t/ha. The crop duration was 108 days from seed to seed. It was also observed that the soil moisture of the farmers field were higher than that of the field capacity during harvest of the rice crop, which was not suitable for setting up of the following winter crop experiments timely as designed. The soil moisture attained to the field capacity ('zo' condition) in the last week of November. Farmers' opined that the T.*aman* rice (cv. BRRI Dhan62) gave comparatively lower yield as compared to their traditional varieties. On the other hand, the mature crop was infested seriously by birds due to becoming early maturity than that of their cultivated other rice varieties. Therefore, the farmers' are not interested to cultivate the T.*aman* rice variety BRRI Dhan 62 in the next year.

Effect of sowing date on the yield of maize in rice based cropping system

The experiment was carried out under on-farm condition at Bandra, Amtali, Barguna under ACIAR/KGF Project during Rabi season of 2016-17 after harvest of T.aman rice (cv. BRRI dhan62). The treatment of the experiment comprised of two factors viz., Factor: A. Sowing date: 5 (25 November, 5 December, 15 December, 25 December and 5 January); and Factor B. Variety: 2 (NK-40, i.e. commercial variety, and BARI Hybrid Bhutta-9, i.e. hybrid variety). The experimental design was split plot, where sowing dates were imposed in the main plots and maize varieties were kept in the sub-plots). There were three replications in this experiment. The unit plot size was 5m × 4m. Maize seeds were sown as per the design of the treatments of this experiment (starting from 25 November 2016 and ending on 05 January 2017). The experimental plot was fertilized with 550-260-220-260-15-7 kg/ha urea, TSP, MoP, gypsum, zinc sulphate and boric acid, respectively along with 6 t/ha cowdung (FRG, 2012). Crop was harvested after attaining the physiological maturity. Data were taken on plant population, days to maturity, plant height, cob length, number of grain/cob, grain weight/cob, 100-grain weight and grain yield. Data were compiled and analyzed statistically. Crop sown on 25-November gave the highest value for all the parameters except plant height. With the advancement of sowing dates, the parameters decreased gradually mainly due to increasing of soil salinity and temperature. Crop grown on 5-January exhibited the lowest performance in terms of yield components and yields. Results further indicated that crop sown on 25-November and 5-December yielded similar but further delay of sowing date reduced the yield remarkably.The result revealed that the optimum sowing time for maize was 25 November to 5 December, but gave similar yield with almost same duration both the varieties(NK-40 and BARI Hybrid Bhutta-9).

Effect of sowing date on the yield of sunflower in rice based cropping systems

The experiment was carried out under on-farm condition at Bandra, Amtali, Barguna under ACIAR/KGF Project during Rabi season of 2016-17 after harvest of previous T.aman rice (cv. BRRI dhan62). The treatment of the experiment comprised of two factors viz., Factor: A. Sowing date: 5 (25 November, 5 December, 15 December, 25 December and 5 January); and Factor B. Variety: 2 (Hisun-33, i.e. hybrid variety, and BARI Surjomukhi-2, i.e. open pollinated variety). The experiment was laid out in split plot design (sowing dates were accommodated in the main plots and sunflower varieties were imposed in the sub-plots) with three replications. The unit plot size was 5m × 4m. Seeds of sunflower were sown following the treatment specifications (starting from 25 November 2016 and ending on 05 January 2017). The experimental plot was fertilized with 200-180-170-170-10-12 kg/ha urea, TSP, MoP, gypsum, zinc sulphate and boric acid, respectively along with 8-10 t/ha cowdung. Crop was harvested after attaining the physiological maturity. Data were taken on plant population, days to maturity, plant height, head diameter, filled grain/head, grain weight/head, 100-grain weight and grain yield. The sowing date 25-November performed the best in terms of yield components and yields. Delay of sowing date reduced the values of the studied parameters. Statistically significant differences were found between the two varieties of sunflower (Hisun-33 and BARI Surjomukhi-2) for all the parameters except plant population. The experimental data revealed that sunflower variety Hisun-33 (hybrid variety) gave comparatively the higher yield and yield components than that of BARI Surjomukhi-2 (open pollinated variety). The interaction between sowing date and variety was not fund to be significant. Numerically, both the varieties (Hisun-33 and BARI Surjomukhi-2) of sunflower performed the best on 25-November sowing date followed by 5-December sowing. The results revealed that the optimum sowing time for sunflower varies from 25 November to 5 December, but var. Hissu gave high yield as compared to BARI Surjomukhi-2.

Increasing cropping intensity and productivity through crop intensification in rice based cropping system

The experiment was carried out under on-farm condition at Bandra, Amtali, Barguna under ACIAR/KGF Project during *Rabi* season of 2016-17 after harvest of T.*aman* rice (cv. BRRI dhan-62) to increase cropping intensity and productivity, sustain food security and increase farmer’s income through crop intensification in rice based cropping system. This area is slight to moderately drought and saline prone, and face salinity at later part of winter season and beginning of summer. Five cropping patterns viz., CP_1 = T.*aman* – Potato – Mungbean –T.*aus*, CP_2 = T.*aman* – Mustard – Mungbean –T.*aus*, CP_3 = T.aman – Gardenpea – Mungbean –T.*aus*, CP_4 = T.*aman* – Spinach – Spinach – Mungbean–T.*aus*, CP_5 = T.*aman* – Fallow – Fallow (Farmers’ practice) were used in this experiment as treatment. The experiment was laid out in randomized complete block design (RCBD) with three replications. The unit plot size was 4.8 m × 4 m. The crop varieties were Cardinal (potato), BARI Sarisha-14 (mustard), BARI Matorshoti-3 (gardenpea), BARI Palongshak-1 (spinach), BARI Mung-6 (mungbean): and BRRI dhan-62 (T.*aman* rice). The winter crops were sown/planted as per the treatment specifications on 26 November 2016. Just after harvesting of winter crops, the kharif crop (mungbean, variety: BARI Mung-6) were sown on 23 February 2017 and harvested on 6 May, 2017. Thereafter, the pre-raised seedlings of T.*aus* rice (25-day old seedlings, variety: BRRI Dhan48) were transplanted in the experimental plots on 11 May, 2017 and the crop is in remains in tillering stage at this moment and not harvested yet. The plant spacings were: T.*aman*: 20 cm × 15 cm, Mustard: 30 cm × 5 cm, Potato: 60 cm × 25 cm, Gardenpea: 30 cm × 5 cm, T.aus: 15 cm × 15 cm, Mungbean: 30 cm ×

5 cm, and Spinach: broadcast. Before seed sowing, fertilizers were applied in the experimental plots as per recommendation by the BARC (FRG 2012). The crops were harvested when they attained the physiolocal maturity or harvestable stages. The everage yield of potato tuber was 18.43 t/ha, mustard gave yield of 1609 kg/ha, green pod yield of garden pea was 2.43 t/ha and green biomass yield of spinach was 12.70 t/ha (Table 2-5). The rice equivalent yield (REY) became the highest (11.29 t/ha) in T.*aman*-Potato-Mungbean-T.*aus* followed by T.*aman*-Spinach-Mungbean-T.*aus* (8.74 t/ha. After harvesting of *Rabi* crops, the following mungbean gave the yields of ranging from 410 to 557 kg/ha. T.*aman*-Mustard-Mungbean-T.*aus* cropping pattern produced the highest yield of mungbean (557 kg/ha.

Screening of sesame genotype against drought

The experiment was conducted in Agronomy Research Field, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-1701, Bangladesh during the period from March, 2016 to June, 2016(Kharif season). This was a second year experiment, which was conducted to screen out the best genotype(s) among the previously selected genotypes. In the first year there were 88 genotypes. On the basis of drought tolerance 28 genotypes from 88 genotypes (in 1styear were selected) for this year. This were BD-10167, BD-6969, BD-6978, BD-6988, BD-6991, BD-6992, BD-6995, BD-6996, BD-7005, BD-7007, BD-7017, BD-7018, BD-7019, BD-7020, Jp-202, Jp-158, Jp-02011, Jp-01912-2, Jp-01911, Jp-00614-2, Jp-01112, Jp-01212, Jp-01712-1, Jp-01712-2, Jp-01611-1, Jp-14014, Jp-14015, Jp-15014. The experiment was laid out in line sowing with 30 cm distance. Pre sowing irrigation was applied for ensuring seed germination then drought were imposed. Same experiment was conducted at the adjacent field in normal condition to compare with drought. In normal condition two (2) irrigations were applied at 16 and 30 DAE. The genotypes were sown on 23 March, 2016 with continuous seeding. The experimental plots were fertilized with 220, 65, 220, 20, 10, 5 kg ha^{-1} urea, triple super phosphate (TSP), muriate of potash (MOP), gypsum, zinc sulphate and boron, respectively. All intercultural operation was same except irrigation both in normal and drought condition. Five (05) plants from each genotype were selected to record the data. Different formula was used to calculate the result. i) Relative Yield (RY) = (Yield of drought stressed plant/Yield of normal plant) × 100, ii) Relative Water Content (RWC, %) = [(W-DW) / (TW-DW)] x 100, Where, W= sample fresh weight, TW= sample turgid weight, DW= sample dry weight, iii) µg proline/gm fresh weight = (µg/ ml proline × volume of Toluene × volume of SS asid)/(o.25 × 115.5). The collected data were compiled and observed that the lines BD-6988, BD-6996, BD-7005, BD-7018, Jp-158, Jp-202, Jp-01911, Jp-00614-2, Jp-01712-2, Jp-14014 showed the best result in drought and normal condition.

Performance of different black gram verities in charland area of Jamalpur

The experiment was conducted at the charland area of Jamalpur during Kharif-II, 2016 to observe the yield performance and popularize BARI blackgram varieties in charland areas. Treatments included in the experiment were: 1) BARI Mash-1, 2) BARI Mash-2, 3) BARI Mash-3, 4) Bina Mash-1 and 5) Local. Design of the experiment was RCB with 3 replications. Each treatment was sown in unit plot having 4m × 3m with the spacing of 30 cm between rows. Fertilizers were applied at the rate of 10-8-10-5 kg/ha of N-P-K-S (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MOP), gypsum. Seeds were sown on September 11, 2016. Weeding was done at 20 days after emergence of the crop. Varietal variations were observed in yield and yield components. The results revealed that BARI Mash-3 produced the highest yield (1217 kg/ha) while other varieties produced lower yield (434-920 kg/ha). BARI Mash-3 might be recommended for taking production program in charland area of Jamalpur District.

Fertilizer management of lentil at char land area of Bhuapur, Tangail

The trial was conducted at the charland of the Jamuna river under the MLT site, Bhuapur, Tangail (AEZ-8) during the rabi 2015-16 & 2016-17 to find out economic fertilizer dose for lentil at the char land of Bhuapur, Tangail and to increase production and economic return**.** The soil of the experimental field was silty loam in texture with pH 6.97 belonging to Grey Floodplain soil (AEZ- 8). The experiment was laid out in RCB design with three replications. The unit plot size was 6 m × 4 m. Five fertilizer doses viz T_1: 24-32-30-18-0.4 kg ha^{-1} N-P-K-S-B (Based on HYG, FRG, 2012), T_2: 21-17-20-0-0 kg ha^{-1} N-P-K-S-B (based on PRC, BARI). T_3: 26-35-20-12-0.3 kg ha^{-1} N-P-K-S-B (Based on STB) T_4: Farmers practice (17-8-19-14-0) and T_5: 0-0-0-0-0 (Native fertilizer/control) were considered as treatments. All the fertilizers were applied at the time of final land preparation in the form of urea, triple super phosphate, muriate of potash, gypsum and boric acid, respectively. Experimental variety was BARI Mosur-6. The unit plot size was 6 m X 4 m. All the fertilizers were applied at the time of final land preparation in the form of urea, triple super phosphate, and muriate of potash, gypsum and boric acid, respectively. The seeds were sown on 1 November, 2016 maintaining 30 cm × 5 cm spacing with seed rate of 35 kg /ha. Two weeding were done at 31 and 53 DAS. The crop was harvested on 5 to 8 March, 2017. Test cv. was BARI Masur-6. The seeds were sown on 23 to 25 November, 2015 maintaining 30 cm × 5 cm spacing with seed rate of 35 kg/ha. Two weeding were done at 31 and 53 DAS. Other necessary managements were done as and when necessary. The crop was harvested on 11 to 13 March, 2016. The results indicated that BARI Mosur-6 along with 26-35-20-12-0.3 kg/ha N-P-K-S-B (Based on soil test) might be suitable for getting highest grain yield (1.44 t/ha) followed by T_2: 21-17-20-0-0 kg /ha N-P-K-S-B (Based on PRC, BARI) (1.315 t/ha). The highest gross returns (Tk. 100800 and Tk. 91700/ ha) and gross margins (Tk. 69971 and Tk. 62584 /ha) were higher in based on soil test basis fertilizer dose.

On-farm trial of wheat varieties in hilly areas

The trial was conducted at Bakichara and Kyamlong para hill valleys in Bandarban during the rabi season of 2016-17 to observe the performance of BARI wheat varieties. Four wheat varieties were evaluated in this experiment. The experiment was laid out in RCB design with three dispersed replications in the farmer's field. The unit plot size was 5m × 4m. Spacing was maintained 20 cm × continuous seeding in line. Seeds of different varieties were sown in different farmer's field on 12-14 December, 2016. The crop was fertilized with 100-35-25-20-1.5-1 kg/ha of N-P-K-S-Zn-B. Two third urea and full amount of all other fertilizers were applied as basal at final land preparation. Rest of the urea was applied as top dress at 3 leaf stage (crown root initiation stage) with first irrigation. Two times weeding were done just before first (20 DAS) and second (55 DAS) time irrigation applied. Third irrigation was applied at seed formation stage (75 DAS). The crop was harvested at full maturity when the stalk and spikes got glittering brown color on 28-30 March, 2017. The highest plant height was observed in BARI Gom-25 (92 cm) followed by BARI Gom-30 (89 cm). The lowest plant height was obtained from BARI Gom-29 (82 cm). The highest no. of spike/m^2 was attained from BARI Gom-30 (416) and BARI Gom-29 (405) while the lowest no. of spike was found in BARI Gom-26 (388). The longest spike was obtained from BARI Gom-25 (12.1 cm) though it was not significantly differed from other varieties (9.7-11.3 cm). Significantly the highest number of seeds per spike was obtained from BARI Gom-30 (25) followed by BARI Gom-25 (23.5) and BARI Gom-29 (23.2). BARI Gom-26 produced the lowest number of seeds per spike (19.1). The higher weight of 1000-grain was recorded from BARI Gom-30 (44 g) followed by BARI Gom-29 (39 g). The highest grain yield was recorded in BARI Gom-30 (3.05 t/ha) which differed significantly from other varieties. The lowest grain yield was obtained from BARI Gom-26 (1.88 t/ha). BARI Gom-30 gave the highest yield because of its higher number of spike m^2 and number of seeds/ spike. The grains of BARI Gom-30 were bold and heavier than the other varieties. There was no infestation of blast.

Performance of garlic varieties at Chalan beel area

The experiment was conducted at the fatmers' field of Chalan beel area under Charkadah village of Gurudaspur upazila in Natore district during *rabi* season of 2016-17 to compare the yield performance of BARI released garlic varieties against local variety with the aim to replace it by the best one. Five garlic varieties viz, BARI Rasun-1, BARI Rasun-2, BARI Rasun-3, BARI Rasun-4 and Italic (local variety) were used as treatment variables.The garlic varieties, viz. BARI Rasun-1, BARI Rasun-2, BARI Rasun-3 and BARI Rasun-4 were compared with local variety Italic. The experiment was laid out in randomized complete block design with three dispersed replications. The unit plot size was 10 m × 2 m. The clove of garlic was planted on the muddy soil like rice seedling transplanting with 13 cm × 8 cm spacing followed by covering with rice straw. Fertilizers at the rate of 161-50-125-27 and 5.5 kg/ha NPKSZn was applied in the form of and urea, TSP, MoP, Gypsum and zinc sulphate, respectively (Uddin *et. al*.2006). Well decomposed cowdung @ 5 t/ha was also used. Urea 1/3 and full amount of other fertilizers were applied in the field before planting. Remaining 2/3 urea was top dressed in two equal installment at 25-30 and 55-60 days after sowing followed by light irrigation. Plant protection assures and intercultural operations were taken as and when necessary. The crop was harvested on 28 March 2017. Data on yield and yield contributing characters were taken and analyzed statistically. BARI Rasun-3 produced maximum yield (12.54 t/ha). Local garlic variety "Italic" might be replaced by high yielding BARI Rasun-3 variety.

Performance of wheat varieties at Chalan beel area

The experiment was conducted at Chalan beel of Shirajgonj during the rabi season of 2016-2017. The treatments were four wheat varieties viz. BARI Gom-25, BARI Gom-26, BARI Gom-29 and BARI Gom-30. The experiment was laid out in a RCB design with four replications. Unit plot size was 8 m× 5 m. The crop was fertilized with 100-36-25-20-1.8-1.0 kg/ha of N-P-K-S-Zn-B. All the nutrients including 2/3 of N were applied as basal. Rest of 1/3 of N was top dressed at CRI stage. Two irrigations were applied at 25 DAE and 50 DAE. Crop field was weeded at 30 DAE. The crop was sown on 20 November 2016 and harvested on 11 March 2017. Data on crop duration, yield and yield components of wheat were recorded. The data was subjected to statistical analysis and mean values were compared by LSD $_{(0.05)}$. There was no blast infestation in the experimental field. Higher yield (4.46-4.83 t/ha) was observed in BARI Gom-26, BARI Gom-29 and BARI Gom-30. Farmers have moderate interest to grow wheat in chalan beel area.

Performance of hybrid maize varieties at chalan beel area

An experiment was conducted at farmers' field of Chalan beel area of Sirajgonj district during the rabi season of 2016-2017 for adaption of low water requiring hybrid maize instead of more water requiring boro rice in Chalan beel area. The treatments were four hybrid maize varieties viz., BARI Hybrid Bhutta-9, NK-40, 900 M Gold and Miracle. The experiment was laid out in RCB design with three replications. The unit plot size was 6m × 5m. Fertilizers were applied at the rate of 256-76-121-72-5-1 kg/ha of N, P, K, S, Zn, B (FRG, 2012) as urea, triple super phosphate (TSP), muriate of potash (MOP), gypsum, zinc sulphate and boric acid. One third of N, whole amount of TSP, MOP, gypsum, zinc sulphate and boric acid was applied as basal. Remaining 2/3 N was top dressed at 30 and 60 days after sowing (DAS). Three irrigations were given at 30, 60 and 90 DAS. The crop was sown on 22 November 2016 and harvested on 15 April 2017. The higher grain yield (10.50 -11.58 t/ha) was observed in Miracle, NK-40, 900M Gold. Farmers are very much interested to grow hybrid maize instead of *boro* rice in Chalan beel area.

Performance of different HYV mustard at chalan beel area

The experiment was carried out at the Chalanbeel area under Kalupara, Tarash upazila on Sirajgong District during rabi season of 2016-17 to evaluate the yield performance of BARI mustard varieties against local variety at chalanbeel area. Three mustard varieties, viz. BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17 were compared with local Tori-7. The experiment was laid out in a RCB design with 4 replications. The unit plot size was 4m × 5m. Tori-7 were grown with 100-32-80-20-3 kg/ha NPKSZn while BARI Sarisha-17, BARI Sarisha-14 and BARI Sarisha-15 were grown with 160-46-120-36-4 kg/ha NPKSZn. Fertilizer rate was selected on the basis of Fertilizer Recommendation

Guide (BARC-2012). One half of nitrogen and full quantity of PKSZn were applied as basal in the form of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. Seeds of each variety were broadcast on November 11, 2016. Remaining half nitrogen was applied at the time of flower initiation (20-25 days after seeding) as top dressing. Three irrigations were given at 12 days after sowing (DAS) and after top dressing at 50 DAS. The crop was kept weed free up to 20 DAS by two hand weedings at 10 and 20 DAS. All varieties were harvested on February 07, 2017. BARI Sarisha-15 was the highest yielder (1.64 t/ha) and it produced 66% higher yield than Tori-7. The results revealed that BARI Sarisha-15 is suitable for cultivation in chalanbeel area.

Adaptation of new potato varieties at Haor area in moulvibazar

The trial was conducted with five HYV Potato BARI Alu-25, BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-41 and local potato variety as check at farmer's field of Haor area of Gumra village of Moulvibazar sadar upazilla during the winter season of 2016-17. The experiment was laid out in RCB design with 3 replications. The unit plot size was 8m × 5m. Seeds were sown on 1 December 2016 maintaining 60 cm × 25 cm plant spacing. Fertilizers were applied @ 115-30-125-22-3.5-2 kg/ha of N-P-K-S-Zn-B + 5 t/ha well decomposed cowdung. All fertilizers and half N were applied during land preparation. The remaining half of N was applied at 35 DAS at 2nd earthing up. Irrigation, intercultural operation and pest management were done as and when necessary. Data were recorded on yield and yield contributing characters and analyzed statistically with MSTAT-C software. Diseases infestation in tubers was higher in BARI Alu-41 (15.89%) and lower (1.0%) in local. Insect infestation in tubers was higher in BARI Alu-35(2.18%) and lower (0.0%) in local. Plant height was the highest in BARI Alu-36 (81 cm) and the lowest in Local (45 cm). Local potato variety exhibited earlier harvesting time (76 days) while BARI Alu-36 required long days for harvesting (90 days). Number of tubers per plant was the highest in local (48) and the lowest in BARI Alu-25 (10). The highest individual tuber weight was found in BARI Alu-36 (23 g) and the lowest was obtained from the local (7 g). BARI Alu-37 produced the highest tuber yield per plant (757 g) and the lowest tuber yield per plant obtained from the local (212 g). The highest yield (and 26.88-26.98 t/ha) were also observed in BARI Alu-35 and BARI Alu-37 while the local variety produced the lowest yield (14.43 t/ha). Boro rice can be replaced by potato in Haor area at this region.

Background

Irrigation and Water Management Division is one of the research divisions of BARI. It conducts research on irrigation scheduling, on-farm water management and generation of basic information of BARI mandated crops. It also generates information through research on water quality, agricultural drainage, pumps and tube wells for both ground and surface waters. Irrigation and Water Management Division is also engaged with saline soil and water management research, climate changes, micro irrigation systems and development of hill irrigation. By this time, this division already developed 45 irrigation and water management technologies and most of them are being used at the farm level.

Effect of deficit irrigation to wheat on raised bed

The experiment was conducted during rabi season of 2015-2016 and 2016-2017 at the Regional Agricultural Research station, BARI, Ishurdi, Pabna to determine the water requirements of wheat on raised bed and the effect of different deficit irrigation on yield, water use efficiency and water productivity under raised bed. The experimental soil was a silty clay loam having field capacity of 28.5%, permanent wilting point at 13% and bulk density of 1.49 g cm-3. Four irrigation treatments were assigned in a Randomized Complete Block Design with three replications. Seed of BARI Gom -28 was sown in unit plots of size was 7 × 7.5 m, on raised bed in 40cm base width, 20cm top width, 15 cm height and maintained 20cm distance between two beds by using the bed planter and was subjected to following irrigation treatments: T_1 = Irrigations up to 100% FC at CRI, botting and grain filling stages (flat bed), T_2 = Irrigations up to 100% FC at CRI, botting and grain filling stages on raised bed, T_3 = Irrigations up to 80% FC at CRI, botting and grain filling stages on raised bed and T_4 = Irrigations up to 60% FC at CRI, botting and grain filling stages on raised bed. The result showed that significant effect of irrigation treatments were observed on plant height, spike per m^2 and grain yield. Highest grain yield (4.66 t/ha) was obtained from treatment, irrigations up to 100% FC at CRI, botting and grain filling stages on raised bed followed by irrigated up to 100% FC at same stages on flat bed. At raised bed wheat cultivation, 14.30% water was saved with 15.66% increase in grain yield than flat bed. Grain yield increased in bed planting compared to flat planting mostly because of deposition of more fertile topsoil on bed and because weeds were also concentrated mainly in furrows owing to the lack of crop cover there and the higher moisture content under the changed land configuration. Bed planting also reduced the soil surface exposed to flooding, eliminating surface soil crusting on top of the bed where wheat was planted. In bed planting, the microclimate within the field was also changed by orientation of the wheat plants in rows on top of the beds, and created favorable soil conditions for mineralization of native as well as applied nutrients. Besides, comparing deficit irrigation (20% and 40% of full irrigation) and full irrigation condition on raised bed seeding system, water use could be reduced about 4.18% to 5.57% while scarifying 18.20% to 32.33% of grain yield, where 14.17% to 27.54% of water use efficiency was reduced. Maximum applied water productivity 1.81 kg m^{-3} was observed under raised bed full irrigation condition. The results will be helpful for taking policy decision regarding efficient irrigation and water management under prevailing water scarce situation.

Effect of deficit irrigation on yield and water productivity of different maize varieties in southern areas

This study was conducted at the Regional Agricultural Research Station, BARI, Rahmatpur, Barisal located at Babugong Upazilla of Barisal District to determine the experimental evidence of the effects of deficit irrigation on yield and water productivity of different maize varieties during 2016-2017. The experiment consisted of two factors: irrigation and variety. The irrigation and variety treatments were: Main plot: Irrigation (5): I_1: Farmer practice, I_2: Full irrigation at initial stage (20-25 DAS), I_3: 50 % irrigation both at initial and vegetative (20-25 DAS and 50-60 DAS) stages, I_4: 75% irrigation at initial, vegetative stage and silking (20-25 DAS, 50-60 DAS and 75-80 DAS) stages, I_5: 50% irrigation at initial, vegetative, silking and grain filling (20-25 DAS, 50-60 DAS,75-80 DAS and 110-120 DAS) stages, Subplot: variety (5), V_1:BHM-9, V_2: BHM-5, V_3: BHM-7, V_4: NK-40, V_5: Pacific-984. The experiment was laid out in Randomize Complete Block Design. Among all Irrigation treatments I_1 produced the highest grain yield of 11.87 t/ha. The values of all the yield contributing characters were observed highest at I_1 except cob perimeter and no of grain per cob. The straw yield, biological yield and harvest index were highest at treatment I_3. On the other hand, V_4 (NK-40) produced the highest grain yield of 10.03 t/ha. The yield contributing characters performed best at V_1 except cob perimeter and 100 grain weight. The parameters were not significant for irrigation treatments but exerted significant difference among the variety treatments. The interaction treatments exerted significant difference. The highest grain yield of 10.03 t/ha was obtained for I_5V_4 (50% irrigation at initial, vegetative, silking and grain filling (20-25 DAS, 50-60 DAS, 75-80 DAS and 110-120 DAS) for NK-40. The highest water productivity for grain production, WP (3.63 kg/m^3), was obtained at I_3 (50 % irrigation both at initial and vegetative; 20-25 DAS and 50-60 DAS stages) and the lowest (1.60 kg/m^3) was obtained at I_1 (Farmer practice). Water productivity decreased with increasing quantity of applied irrigation.

Design, development and assessment of the economic suitability of a permanent floating bed for cultivating vegetables round the year

The experiment was conducted at RARS, BARI, Rahmatpur, Barisal during 07 November, 2016 to 06 March, 2017 to develop a low cost permanent bed for floating agriculture and to determine the socio-economic suitability of the permanent bed as compared with the traditional bed to grow crops round the year. Two plastic pipes (4″) of 20′, another two plastic pipes (4″) of 4′ 3″ and four elbows were used for making the permanent bed. The four elbows (4″) were connected at the end of two 20′ long pipe (4″) by plastic gum. Then the two pieces of 4′ 3″ long pipe (4″) were jointed between four elbows (4″) by plastic gum. After that the permanent bed was covered by plastic sheet and net (1″) to protect the bed materials (water hyacinth) from fish. The plastic layer was used, so that the sunlight could not affect the plastic pipe. As the bed height was short (9 inch) the fibrous roots was came out quickly, as they got some source of nutrients from the bed materials. So some correction was needed to grow carrot in permanent bed. It was observed that the yield of potato was 10.65 t/ha. The yield was found 4.16 t/ha for green pod and for dry seed yield, it was found 0.35 t/ha. As it was the first year experiment, it needed to verify with the yield data of carrot, potato and bush bean under land cultivation.

Estimation of crop co-efficient values of radish (seed) by lysimeter

This study was done on radish as seed (Variety: BARI Mula-4) during rabi season (Early-November to Mid-March) of 2016-2017 at Irrigation and Water Management Division, Bangladesh Agricultural Research Institute, Gazipur in a micro-lysimeter (dimension: 1m×1m×1m size) to measure the daily evapotranspiration of the crop (ET_c) and crop coefficient (K_c) values. Crop was grown within and outside of the tank, providing recommended fertilizer doses and standard intercultural operations to maintain favorable atmosphere for maximum plant growth. Irrigation was applied at four distinct intervals (7, 12, 17 and 22 days) in four different lysimeter tanks allowing sufficient drainage. After harvesting it was found that, irrigation at 15 days interval produced the highest seed yield (2.52 t/ha); therefore, it was considered to be suitable for estimating ET_c and K_c. From the calculation, it was found that K_c values of BARI Mula-4 (seed) at initial (0-24 DAS), development (25-60 DAS), mid-season (61-108 DAS), and late-season (109-129 DAS) stages are 0.61, 1.30, 1.64, and 0.86, respectively. Experimental results suggest that at initial stage ET_c per day was much lower than that of the daily ET_0 values, thus, K_c was the lowest (0.61). In contrast, at later two stages K_c was greater because of higher values of daily ET_c soared over the corresponding ET_0 values due to higher consumptive use. Like most of the other crops, K_c value at late season went down again (0.86). Some of these values were found higher than that of the values determined by FAO; however, the findings could be handy for local agricultural researchers, academicians and farmers in proper irrigation scheduling as well as in water management planning.

Effect of water stress at different growth stages on the yield of mustard

The experiment was conducted at IWM research field, BARI, Gazipur, and at the research field of RWRS, Shympur, Rajshahi during the rabi season of 2015-2017 with BARI Sarisha-14. There were five irrigation treatments, T_1 = Full irrigation at pre-flowering (25-30 DAS) and pod formation (50-55 DAS) stage, T_2 = $DI_{80\%}$ up to FC at pre-flowering (25-30 DAS) and pod formation (50-55 DAS) stage, T_3 = $DI_{60\%}$ up to FC at pre-flowering (25-30 DAS) and pod formation (50-55 DAS) stage, T_4 = $DI_{80\%}$ at pre-flowering (25-30 DAS) stage, and, T_5 = $DI_{80\%}$ at pod formation (50-55 DAS) stage. Each replicated thrice in a randomized complete block design. Basin irrigation method was used. It was found that deficit irrigation (DI) utilized less seasonal water to produce the optimum yield, and the highest water productivity as well as the higher net return compared to full irrigation. This irrigation technique produced somewhat lower plant growth parameters (biomass and LAI) with compared to full irrigation. Seasonal water use was found to be 107.05 mm, and 151.3 mm for 80% deficit irrigation up to FC at pre-flowering stage (T_4) for Gazipur during two consecutive years, while for Rajshahi it was 116.05 mm and 164.7 mm. Average over two years, the highest seasonal water use of 129.2 mm and 140.4 mm were found in treatment T_4 for Gazipur and Rajshahi. The highest water productivity (WP) was found to be 1.58 kg/m^3 and 1.26 kg/m^3 for treatment T_4 for Gazipur for both the consecutive years, whereas in Rajshahi it was 1.23 kg/m^3 and 0.79 kg/m^3. Average over two years, the significantly highest water productivity of 129.2 mm and 140.4 mm was found in treatment T_4 for Gazipur and Rajshahi. This treatment ($DI_{80\%}$ at pre-flowering stage) saved more than 50% water to produce 1.69 t/ha and 1.61 t/ha for Gazipur, and 1.43 t/ha and 1.30 t/ha for Rajshahi for the consecutive years. This treatment also gave the highest net return of 1.15 lakh and 1.76 lakh Tk. Per ha of land for Gazipur for two years, while for Rajshahi, it was 0.70 lakh 0.43 lakh Tk. per ha of land respectively. From this study, it can be said that BARI Sarisha-14 at $DI_{80\%}$ at pre-flowering stage can produce the optimum yield for water scarce regime if soil moisture at the sowing time is available. The grains of the crop under this treatment matured early than that of other treatments and can be treated as suitable for increasing cropping intensity under water scarce region in Bangladesh.

Effect of deficit irrigation and mulch on the yield and quality of pumpkin

The experiment was conducted at IWM research field, BARI, Gazipur, during the rabi season of 2016-2017 with BARI Hybrid Mistikumra-1 with a view to determine the effect of deficit irrigation and mulching on growth and yield of pumpkin, and to compare the economic feasibility of full irrigation (FI) and deficit irrigation (DI). There were seven irrigation treatments, each replicated four times in a randomized complete block design. The irrigation treatments were: T_1 = FI using ring basin method at 10 days interval with mulch, T_2 = FI using ring basin method at 15 days interval with mulch, T_3 = $DI_{25\%}$ using ring basin method at 10 days interval with mulch, T_4 = $DI_{25\%}$using ring basin method at 15 days interval with mulch, T_5 = $DI_{50\%}$ using ring basin method at 10 days interval with mulch, T_6 =

$DI_{50\%}$using ring basin method at 15 days interval with mulch, and, T_7 = Drip irrigation at 3 days interval with mulch. Fertilizers were applied at the rate of N_{75}, P_{36}, K_{60}, S_{21}, Zn_2, $B_{1.4}$ kg ha^{-1} and cowdung 5.0 t ha^{-1}. It was found that deficit irrigation (DI) utilized less seasonal water use to produce the optimum yield, and the highest water productivity, percentage water saved, and net return in compared to full irrigation. This irrigation technique reduced plant growth (vine length) in compared to full irrigation. Seasonal lowest water use and highest water productivity was found to be 1138 mm, and 2.21 kg/m^3; and 977 mm and 1.93 kg/m^3 for treatment T_7 and T_6. These treatments (T_7 and T_6) saved about 47% and 43% water to produce 25.20 t/ha and 18.88 t/ha of yield. These treatments also gave the highest net return of 8.87 lakh and 7.82 lakh Tk. Per ha of land and BCR of 7.36 and 6.10.

Estimation of crop co-efficient values of jute by lysimeter

The experiment was conducted on Jute (variety: O9897) crop during the month of mid- April to first week of August in a lysimeter (dimension: 1 m X 1 m X 1 m size) which measures the daily evapotranspiration of the crop (ET_c) and crop coefficient (K_c) values during 2016 at Irrigation and Water Management Division, Bangladesh Agricultural Research Institute, Gazipur. The study was done by applying four levels of irrigation at an interval of 7, 14, 21, and 28 days after sowing allowing drainage within and adjacent of four lysimeter tanks. Irrigation at 14 days interval produced the highest dry fiber and was considered to be suitable for estimating ET_c and K_c. The highest seasonal ET_c was found to be 549.13 mm/day. The K_c values of jute at initial, development, mid-season and late season were found to be 0.72, 1.39, 1.26, and 0.46. As there was no recommended K_c value for this crop, so it may be used for similar climatic conditions of Bangladesh.

Response of available soil moisture on the growth and yield of chickpea

The experiment was conducted at the experimental field of IWM Division, BARI, Gazipur and farmer's field of Godagari, Rajshahi during 2015 -2016 and 2016-2017 to investigate the response to available soil moisture on growth and yield of chickpea. Four levels of irrigation were applied for the experiment with four replications. The treatments were T_1= Rainfed, T_2= one irrigation (light irrigation of 1.0-1.5 cm) at post-sowing, T_3= one irrigation (light irrigation of 2-3 cm) at pod development (80-85 DAS) stage, T_4= Two irrigations given each at post-sowing and pod development (80-85 DAS) stages. The selected crop was chickpea and the variety was BARI Chola-9. Seeds were sown on 16 November, 2016 at Gazipur and 22 November, 2016 at Godagari, Barind, Rajshahi at a spacing of 25 cm plant to plant and 40 cm line to line. Soil moisture at every 10 days interval was measured. Measured amount of water was applied to each plot as per treatment to maintain the soil moisture content in the root zone depth up to field capacity. Ten plants from each plot were selected randomly for collecting growth data including root length, shoot length, canopy coverage and biomass. The results showed that most of the parameters were found higher in treatment T_2 and T_4. The growth parameters (root length, shoot length, biomass) were found almost the highest in higher water used treatment and the lowest was found in rainfed treatment. It was observed that, treatment T_1 produced comparatively less biomass than treatment T_2 and T_4 in 2015-2016 and 2016-2017. Results also showed that, treatment T_2 gave the highest seed yield of 1.55 t/ha in both the locations at Gazipur and at it was 1.33 t/ha at Rajshahi in 2015-2016. The treatments T_4 and T_3 gave the highest yield of 1.84 t/ha in Gazipur and in Rajshahi it was 1.43 t/ha during 2016-2017. Seedling stage and pod development stages of chickpea were found critical to irrigation. If there is considerable rainfall (that will be helpful for pod development) then one irrigation at post sowing stage (T_2) is adequate for chickpea cultivation. But if there is no rainfall then one irrigation at pod development stage (T_3) or two irrigations at pod development + post sowing stage (T_4) are needed to produce highest pod per plant, grains per pod and yield. Treatment T_2 (one irrigation (light irrigation of 1.0-1.5 cm) at post-sowing stage) yielded the highest seed for 2015-2016 at Joydebpur and Rajshahi. Treatment T_3 (one irrigation (light irrigation of 2-3 cm) at pod development (80-85 DAS stage) yielded the highest seed for 2016-

2017 at Rajshahi and treatment T_4 (one irrigation (light irrigation of 1.0-1.5 cm + one irrigation (light irrigation of 2-3 cm) at pod development 80-85 DAS stage) yielded the highest seed for 2016-2017 at Joydebpur. Financial feasibility was also found better with the application of single irrigation at post sowing than other treatments considering rainfall but without any rainfall, it was found better with the application of two irrigation at post sowing plus pod development stages than other treatments. In both the years total seed yield followed the following trend $T_2>T_3>T_4>T_1$ and $T_4>T_3>T_2>T_1$.

Assessment of water use for the growth and yield of white grained hybrid maize

The experiment was conducted at the experimental field of IWM Division, BARI, Gazipur and farmer's field of Godagari, Rajshahi during 2016 -2017 to assess the water use on the growth and yield of white grained hybrid maize line. Five levels of irrigation were applied for the experiment with four replications. Treatments were T_1= Rainfed, T_2= One irrigation at pre-flowering (55-65) DAS stage, T_3=One irrigation at grain filling (90-100 DAS) stage, T_4= Two irrigations each at pre-flowering (55-65 DAS) and grain filling (90-100 DAS) stages, T_5= Three irrigations each at vegetative (25-30 DAS), pre-flowering and grain filling stages. The selected crop was maize and the advanced line of white grained Hybrid maize line: ($P_1 \times P_7$). Seeds were sown on 11 December, 2016 at Joydebpur at a spacing of 20 cm plant to plant and 60 cm line to line and in farmer's field of Kadamshahar, Godagari, Barind, Rajshahi; seeds were sown on 03 December, 2016 at the same spacing. The crop was harvested on 7 May 2017 at Joydebpur and 8 May 2017 at Rajshahi. The results showed that the values of most of the yield contributing characters were found higher in treatment T_5 for both locations where three irrigations were applied at vegetative, pre-flowering and grain filling stages. The treatment T_5 gave the highest yield in both the locations at Gazipur (6.80 t/ha) and at Rajshahi (5.80 t/ha), where three irrigations were applied at vegetative, pre- flowering and grain filing stages and the lowest yield (4.77 t/ha) and (4.28 t/ha) were found in treatment T_1 at Gazipur and at Rajshahi where no irrigation was applied. But in Gazipur, treatment T_2 and T_4 were identical and there was almost no significant difference over the treatment T_5. Treatment T_2 (6.10 t/ha) performed well compared to T_4 (6.30 t/ha) and T_5 (6.80 t/ha). That means irrigation at grain filling stage and vegetative stages do not have much effect on yield without irrigation at pre-flowering stage. As there was about 80 mm rainfall at Gazipur and about 50 mm rainfall at Rajshahi during reproductive stage (March 2017). So, less irrigated treatments got a significant effect of rainfall. That's why; there was not significant yield variation among the treatments. The highest BCR of 1.35 was found in treatment T_5 at Gazipur.

Testing aquacrop model in simulating yield response of maize to full and deficit irrigation

Accurate crop models are important tools for predicting crop yields to optimize irrigation under limited available water for enhanced sustainability and profitable crop production. The FAO AquaCrop model predicts crop productivity, water requirement, and water productivity under water limiting conditions. The performance of AquaCrop model was evaluated for maize using data from a field experiment conducted in the research field of IWM Division, BARI, and Gazipur, Bangladesh during winter season of 2015-2016. There were five treatments; T_1= Rainfed, T_2 = Irrigation at seedling, vegetative, silking and grain filling stages (full irrigation), T_3 = Irrigation at vegetative, silking and grain filling stages (stress at early stage), T_4 = Irrigation at seedling, vegetative and grain filling stages (stress at mid stage), and T_5 = Irrigation at seedling, vegetative and silking stages (stress at late stage). The input data files of climate, crop, soil, irrigation, and initial soil water conditions for AquaCrop model were assembled using the field data. The model predicted the aboveground biomass and grain yield with acceptable accuracy under rainfed, full and deficit irrigated conditions. The predicted values of final aboveground biomass were about 16.0% of the measured values while the predicted maize grain yields were 6.54% of measured values, except in the rainfed treatment.The results showed high goodness of fit between the observed and the simulated biomass yield for all treatments with index of agreement (d) values ranged from 0.96 to 0.98, root mean square error

(RMSE) from 1.11 to1.26 t/ha and model efficiency (E) from 0.96 to 0.98. High reliability of AquaCrop for the simulations of grain and biomass yield implies that, it can be used as a valuable tool for estimating crop productivity under various irrigation strategies.

Growth, yield and quality of mandarin as influenced by fertilizer application and methods and amount of irrigation in the hilly region

An experiment was conducted at Hill Agricultural Research Station, Khagrachari on the existing orchard to find out the growth, yield and quality of mandarin influenced by fertilizer application and methods and amount of irrigation. The experiment was set up during December 2016 at a 4-years old orchard of mandarin (var. BARI Komola-2). Plant to plant spacing was 5m × 5m. Six treatments were distributed in a Randomized Complete Block Design with 4 replications. The treatments were T_1: Farmers' practice; T_2, T_3 and T_4 consisted of irrigation by ring basin method at 15 days interval (November-May) with fertilizer applied at 2, 3 and 4 months interval, respectively; T_5 and T_6 were of drip irrigation at 5 days interval (November-May) with fertilizer application at 2 and 1 month's interval, respectively. As the experiment was started when fruits attained maturity, it is obvious that the treatments could not contribute to growth, yield and quality of mandarin. However, initial data of the plants viz. canopy length, plant height and stem diameter were taken. This is an on-going experiment, therefore, effects of the treatments will be visible after this year's harvesting of fruits. Further observations will be made in the next years.

Sustainable groundwater utilization for crop production in Rajshahi district

This study was conducted in nine upazillas of Rajshahi district for the optimized groundwater utilization for crop production to know the crop water requirement for the existing crops, crop water availability and needs optimize use of groundwater for the target area. Monthly groundwater level data for the years of 1995 -2016, data for irrigated crops, irrigated area for the years of 2014-2016, number of wetted area and depth of wetted area have been collected from Barind Multipurpose Development Authority (BMDA). More primary and secondary data as per requirements of the sustainability indicators will be collected from different sources. After collecting all relevant data, data will be analyzed through relevant software or tool. The data that are already collected have been calculated in excel and plotted in graph to get preliminary concept on irrigated area, wetted area, abstraction from surface and groundwater, groundwater level etc. for the study area. Results of the preliminary analysis indicated that irrigated area is decreasing for boro rice, wheat, mustard and little bit for maize. For tomato/lentil and other crops (except aus and aman rice, it is in fluctuating condition), the irrigated area is increasing. But the total irrigated area for all crops is increasing for the current year compare to previous year. Total amount of abstracted water is decreased for the current year 2016-17 compare to previous year as the most dominating crop boro rice area decreased. Due to limited surface water sources in the study area, only 30 Mm^3 water of total abstraction (641.48 Mm3 in 2016-17) is abstracted from surface sources and rest of the abstracted water comes from groundwater. Preliminary analysis of groundwater level data for nine upazillas of Rajshahi district is indicated that groundwater level is declining with time for the year of 1995-2015 which causes a vulnerable situation. In the month of April and sometimes in May, the highest groundwater level declination is observed compare to other months. Among nine upazillas, the highest declining trend is found in Tanore, Godagari-2, Mohonpur, Baghmara, Durgapur whereas Bagha-2 upazilla is in better situation among them. However, this is first year study. After collecting and analyzing all data, the critical situation for groundwater depletion will be minimized by reducing the groundwater abstraction and by less water consuming crop production through appropriate water management technologies.

Performance of different types of emitters for drip irrigation system

This study was done during December to March of 2016-2017 at Irrigation and Water Management Division, Bangladesh Agricultural Research Institute, Gazipur to evaluate the hydraulic performances and yield performances of different emitters. Four different types of drippers were considered as four treatments; T_1: Imported (Chinese) emitter type-1, T_2: Imported (Chinese) emitter type-2, T_3: Local emitter type-1, T_4: Local emitter type-2. Research was done under two major components: (i) evaluation of hydraulic performances, (ii) evaluation of yield performances. Standard methods and materials were used for both component; where tomato (BARI Hybrid Tomato-15) were used to test the yield performances. From the experiment, it was found that both Chinese emitters (T_1 and T_2) provided quite stable discharge rate against pressure variation, though discharge rate of T_1 were little higher than T_2. In contrast, both types of Local drippers (T_3 and T_4) had very unstable discharge rates, where discharge amplified significantly as the water pressure at the inlet upraised. On the other hand, T_1 and T_2 also exhibited virtually persistent trend in discharge rate with the advancement in lateral length. However, both T_3 and T_4 exhibited very unstable discharge rates, where, discharges decreased progressively as the distance along the lateral increases. The calculated C_v values proved that T_3 and T_4 emitters were very good (if not excellent) in terms of manufacturing quality as the values were within 0.07 limit at all pressure levels. Again, both local drippers (T_3 and T_4) had C_v values (under different pressures) which are not within acceptable limit. EU, EU_a, and EU_f values were also found excellent (around 90 percent) for T_1 and T_2 under all operating pressures. Quite the reverse, T_3 had emission uniformity values less than 70 percent at almost all the cases, these values were even worse in case of T_3, especially at low pressures. T_1 had FV values within the range of 19% to 14%, where FV's were between 18% to 10% in T_2; thus, both emitters can be considered as good. Once again, both T_3 and T_4 had FV values which were not within acceptable range (45% to 72%). The crop component of the experiment showed that the marketable yield (MY) and cull yield (CY) of tomato were affected significantly by the emitter types, though the effects on yield contributing characters were insignificant. Highest marketable yield (58.29 t/ha) was found in T_2, where, the lowest MY (43.58 t/ha) was at T_4. However, cull yield was highest in T_4 and lowest in T_1. Concisely, it can be concluded that both Imported (Chinese) emitters had better performances (hydraulic and crop yield) with comparison to the locally available drippers. Finally, based on the results found from this study, these four drippers can be ranked as $T_2 > T_1 > T_3 > T_4$ (best to worst).

Growth and yield of sweet orange as influenced by timing of fertilizer application and method of irrigation

This study was carried out at the experimental field of Irrigation and Water Management Division, Bangladesh Agricultural Research Institute, Gazipur to determine the appropriate timing of fertilizer application and the irrigation method on the growth and yield of sweet orange. The experiment was designed with five treatments and five replications. The treatments were: T_1 = Rainfed (normal practice), T_2 = Irrigation at 10 days interval by ring basin method (November-May) with recommended fertilizers applied two times in a year, T_3 = Irrigation at 15 days interval by ring basin method (November-May) with recommended fertilizers applied four times in a year, T_4= Drip irrigation at five days interval (November-May) with fertilizer application at two months interval, T_5 = Drip irrigation at five days interval (November-May) with fertilizer application at once in a month. Results of this study indicated that the plant height and stem diameter were observed greater in treatment T_3 than other treatments. Yield contributing parameters (fruit length and diameter) and total yield were found to have almost similar trend of T_2, T_3, and T_4 but higher than T_1 and T_5. The treatment T_3 with irrigation at 15 days interval by ring basin method with fertilizers applied at three months interval and the treatment of T_4 with drip irrigation at five days interval with fertilizer application at two months interval performed better in plant growth and fruit yield than other treatments. Seasonal irrigation water use was lower in treatment T_4 and T_5 than T_2 and T_3 in each year. Drip or ring basin method could be an irrigation strategy for sweet orange cultivation due to better plant growth, number of fruits, fruits length and diameter, yield and water use. However, this is an on-going study, and for the fourth time, excellent bearing is being observed during the year of 2016 and 2017.

Effect of alternate furrow irrigation on growth, yield, quality and water productivity of potato

A new method of furrow irrigation was used to investigate the effect of alternate furrow irrigation (AFI) on potato cultivation at the research field of Irrigation and Water Management Division under Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during *Rabi* season of 2015-2016 and 2016-2017 to assess the dry matter, tuber yield, water productivity (WP) and nutrient uptake in tubers in respect of irrigation levels and methods. Therefore, a factorial field experiment was conducted as a randomized complete block design with six treatments replicated thrice. The treatments consisted of two irrigation levels and three furrow irrigation methods. Two irrigation levels were (i) I_1: three irrigation each at stolonization (20-25 DAP), tuberization (40-45 DAP) and at tuber enlargement (60-65 DAP) stages, (ii) I_2: Irrigation at 12-15 days interval. Three irrigation methods consisted of (i) Alternate furrow irrigation (AFI), (ii) Fixed furrow irrigation (FFI) and (iii) Every furrow irrigation (EFI). Results showed that dry matter and tuber yield of potato did not differ significantly between the treatments of AFI and EFI, but significant difference was observed when AFI and EFI were compared to FFI. On an average, AFI and EFI produced tuber yield around 21.89 t/ha and 22.2 t/ha under the level of three irrigations and 23.2 t/ha and 23.92 t/ha when irrigated with the level of four irrigations, respectively over two years (2016 and 2017).AFI saved irrigation water by 35-37% compared to that of EFI and WP was statistically improved in AFI by 32-34% (on average 14.84 kg/hm^3) compared to EFI (on average 9.9 kg/m^3) when irrigation was applied at three critical stages and 12-15 days interval over two years. The concentration of nutrients (N, P, K, Zn and B) uptake content in tubers were found similar trends in AFI and EFI. Tuber quality in respect of TSS was found to be non-significant in AFI (6.29 ^{0}Brix) and EFI (6.37 ^{0}Brix). However, AFI is also a useful water-saving irrigation technique which may be as an alternate choice compared to EFI in the areas where available water is limited for irrigation.

Effect of irrigation amount and frequency on the growth and yield of onion under sprinkler system

This study was conducted for onion (Allium cepa) grown on silty loam soil in the Research field of IWM Division, BARI, Gazipur during December to March of 2015-2016 and 2016-2017 to evaluate the effects of different irrigation frequencies and levels on the growth and yield of onion and to determine the water productivity associated with the amount of water application under sprinkler irrigation system. The effect of changes of the irrigation frequency on the component balance was also investigated. The treatment comprised of three levels of irrigation frequency (Sprinkler irrigation at 6, 9 and 12 days interval) and four levels of irrigation amount (Sprinkler irrigation at 60%, 80%, 100% and 120% ET_c) with split plot design. All frequencies of a particular irrigation treatment received the same amount of irrigation water throughout the season. Results showed that both irrigation regime and irrigation frequency caused a significant ($P \leq 0.05$) variation in bulb yield of onion. Irrigation frequency at 12- day interval produced the lowest bulb yield at all levels of irrigation regimes, so should be avoided for onion crops. Irrigation at 6- and 9 -day interval produced the higher yield and were comparable to each other. Deficit irrigation regimes (60% ETc and 80% ETc) gave the better results under 9-day frequent irrigation than under 6-day frequent irrigation. This was reverse in case of higher water regimes. Bulb yield increased significantly at each irrigation level from 60% ETc to 100% ETc; however, from 100% to 120% ETc the increase in yield was insignificant. Thus, irrigation at 6-day interval with 120% ETc produced the highest bulb yield of 15.27 t/ha, while the second highest yield of 14.87 t/ha occurred at 100% ETc irrigation regime at 9-day interval. In all cases, 12-day frequent irrigation resulted in lower yields than other irrigation frequencies. WUE ranged between 6.32 and 7.41 kg/m^3 for 6-day frequent irrigation, between 6.76 and 7.91 kg/m^3 for 9-day frequent irrigation with maximum value in 80% ETc and minimum value in 60% ETc. Irrigation frequency at 12-day resulted in poor WUE ranged from 4.58 kg/m^3 for 60% ETc to as much as 6.72 kg/m^3 for 100% ETc as water supply at longer interval leads to lower yields than 6- and 9-day frequent irrigations. Thus, irrigation frequencies found to be important with irrigating at 6- or 9-day interval instead of 12-day interval leading to an increase of the root-zone water storage, higher water productivity and higher yields.

Water management for four-crop based cropping patterns in Barind area

The efforts were made to study the four-crop based cropping pattern to find out effective water management practices for maximizing the net returns per unit of area per unit of available water resources in Barind area. Five different cropping patterns: two four-crop based patterns with the inclusion of a pulse crop such as Mustard-Mung-T.aus-T.aman and Potato-Mung-T.aus-T.aman; two three-crop based patterns that are popular practice of the study area such as Tomato-T.aus-T.aman and Wheat-T.aus-T.aman; and one double rice pattern T.aman-T.aus were compared in terms of their total water use, water productivity and profitability. The study concluded that the cropping pattern with Boro and T.aman rice would not be feasible in terms of water productivity and benefits. Inclusion of vegetable crops-tomato and potato showed potentiality in the study area with the available water resource to get maximum rice equivalent yield (REY), water productivity and net returns. For example, inclusion of tomato in double rice pattern increased the total water use (TWU) from 1418 mm to 1954 mm, about 35% incrase, and water productivity (WP) from 0.56 to 1.49 kg/m^3; about 166% increase. Of the two four- crop based pattern, the pattern with potato produced REY of 24.96 t/ha/yr almost double the pattern with mustard (12.70 t/ha/yr), though their difference in TWU was minimal, only 114 mm. Almost in all cases, TWU and REY were found highest under BARI recommended standard irrigation management practices. But the WPs were found higher under deficit water management practices for cereal crop based patterns, not for vegetable crop based pattern. The maximum profitability, in terms of net return and BCR, was obtained by adopting the vegetable crops in the cropping sequence. So, inclusion of vegetable crops even other non-rice rabi crops instead of boro rice can significantly reduce the irrigation water requirement and increase the rice equivalent yield (REY), WP as well as profitability.

Conjunctive use of saline and fresh water for crop irrigation in coastal areas

An experiment was conducted at the Agricultural Research Station, Benerpota, Shatkhira; Bangladesh Agricultural Research Institute during *Rabi* season of 2016-2017 to investigate the response of wheat (variety: BARI Gom–25) and maize (variety: BARI Hybrid Maize–9) to conjunctive use of saline and fresh water for irrigation. Groundwater with marginal salinity of 1.5-2.8 dS/m was considered as fresh water, whereas water (4.25-8.5dS/m) from nearby canal was considered as saline water. For both the crops, the number of irrigations, crop growth stages, and sources of irrigation water were varied among the treatments. The treatments for wheat were: T_1= Two Irrigation: at CRI (17-21 DAS), booting (50-60 DAS) with fresh water, T_2= Two Irrigation: at CRI (17-21 DAS) stage with fresh water + irrigation at booting (50-60 DAS) stage with saline canal water, T_3= Three Irrigation: at CRI (17-21 DAS) stage with fresh water + irrigation at booting (50-60 DAS) and grain filling (75-85 DAS) stages with saline canal water, and, T_4= Three Irrigation: at CRI (17-21 DAS), booting (50-60 DAS) and grain filling (75-85 DAS) stages with saline canal water. Whereas, treatments for maize were: T_1= Two Irrigation: at vegetative (40-50 DAS), tasseling (75-80 DAS) stages with fresh water, T_2= Two Irrigation: at vegetative (40-50 DAS) stage with fresh water + irrigation at tasseling (75-80 DAS) stage with saline canal water, T_3= Three Irrigation: at vegetative (40-50 DAS) stage with fresh water + irrigation at tasseling (75-80 DAS) and grain filling (100-110 DAS) stages with saline canal water, and, T_4= Three Irrigation: at vegetative (40-50 DAS), tasseling (75-80 DAS) and grain filling (100-110 DAS) stages with saline canal water. The experimental results showed that different irrigation treatments have statistically significant effect on yield attributing parameters as well as yield of wheat. The number of spike/ m^2, number of spikelet/ plant, and spike length were highest in T_1, which involved with two freshwater irrigation. However, T_3 (three irrigations: first one with fresh water and next two with saline water) produced highest values for other yield attributes (plant height, number of grain/ plant, and 1000 grain weight was maximum in the). Both grain yield (3.49 t/ha) and straw yield (2.67 t/ha) of wheat were also found maximum in T_3, whereas, second highest was found in T_1 (two irrigations: both with freshwater) and lowest was in T_4 (three irrigations: all with saline water). Similarly, statistically significant effects of irrigation water salinity on yield and yield attributing characters of maize were observed from the results. Here also, all the growth and yield parameters (plant height, number of cob/ plant, cob length, cob diameter, number of row/ cob, number of grain/ cob, and 1000 grain weight) and yields (grain yield was 10.54 t/ha and straw yield was 11.81 t/ha) of maize were found highest in T_3. The second highest values were observed in T_1 for all the cases, and T_4 produced the lowest values in every time. The obtained results for both wheat and maize clearly indicates that the moderately saline canal water (5.5-4.8 dS/m) can be a very handy source of irrigation water for rabi crops, when fresh water is relatively scarce. Instead of reducing the number of irrigation events, freshwater irrigation at sensitive stages combined with saline canal water irrigation at later stages can minimize yield loss for moderately saline tolerant crop varieties like wheat and maize. However, similar studies need to be continued to observe the long run effect of saline water irrigation in soil profile.

Impact of irrigation water salinity on growth, yield and water use of wheat

Water and soil salinity are important factors determining crop growth and yield, especially, in the saline soils. A field experiment was conducted at the experimental field of IWM division of Bangladesh Agricultural Research Institute, Gazipur during December- March 2015-2016 and 2016-2017 to investigate the effect of irrigation water salinity on the growth, yield components and yield of wheat. Irrigation with four fixed levels of salinity (4, 7, 10 and 13 dS/m) and one varying levels (salinity increased as plant grow older) of saline water were compared with fresh water (<0.5 dS/m) irrigated (control) treatment. All the growth and yield components were found negatively affected by irrigation with different levels of saline water. The decreases of growth and yield parameters were not significant up to the salinity of 7 dS/m. Beyond this, a strong negative effect was observed on almost all growth and yield contributing parameters like plant height, rooting density, leaf area index, spike length, spikelet per spike, number and weight of grain per spike, 1000- grain weight and biomass yield. In all cases, the highest values were recorded in control and the lowest were recorded in higher levels of salinity. Irrigation with saline water of 4 dS/m and fresh water gave identical results in term of growth, yield and yield contributing parameters. Over the years, the highest grain yields of 4.29 t/ha and 3.87 t/ha were found in the control treatment and low salinity treatment in the first and second season, respectively, while the lowest yields of 3.03 t/ha and 2.43 and were found in the high salinity treatments. On an average, compared to the low salinity level, medium (10 dS/m) and high salinity (13 dS/m) levels reduced the grain yield by 20.65 and 31.72% and biomass yield by 20.1 and 33.0%, respectively. Whereas varying levels of salinity reduced the grain yield only by 10.24% and biomass yield by 15.88%. The water uses by the crop ranged from 204 to 258 mm in the first season and 212 to 283 mm in the second season with maximum in no salinity treatment and minimum in high salinity treatment. Applying irrigation at varying level of salinity gave almost similar results in terms of growth, yield and yield components with 7 dS/m salinity level. This treatment gave the highest water productivity of 1.70 and 1.88 kg/m^3 in the first and second seasons, respectively, with 223 and 243 mm of total water use. Therefore, irrigation with low saline water at the early growth stages and higher salinity water at the later stages might be a good option for growing wheat in saline environment.

Sustainable crop production in drought and saline coastal areas of Bangladesh under changing climate

The project aims to develop the suitable water management practices based on major cropping patterns in saline and drought prone areas of Bangladesh under climate change situation. The coastal districts selected for conducting cropping pattern based experiments were Barguna, Khulna and Satkhira, and the drought prone districts were Kushtia, Rajshahi and Rangpur. Every crop in major cropping patterns of that area received four different water management practices varied according to crops. From the experiments conducted during 2014-2017, it was seen that non-rice dominant cropping pattern had lower water use with higher water productivity. In salt prone areas, both rice equivalent yield and water productivity was found higher in T_2 water management where modest amount of water was applied through irrigation, while in drought prone areas though the higher WP was obtained mostly from T_2 irrigation management, the highest rice equivalent yield (REY) was obtained from T_4 irrigation practices where higher amount of water was applied through irrigation. In saline prone area, Tomato-Jute-T.Aman had the highest REY and WP (54.60 t/ha and 5.73 kg/m^3) followed by Tomato-T.Aus-T.Aman (41.51 t/ha and 2.85 kg/m^3) and Watermelon-T.Aus-T.Aman (38.21 t/ha and 2.74 kg/m^3) cropping patterns were obtained from T_2 water regime. Total water use was found the lowest in Mustard-Mung-T.aman and Wheat-Mung-T.aman patterns. The highest water used pattern was Mustard-Boro-T.Aman with lowest water productivity of 0.72-0.86 kg/m^3. On the other hand, in drought areas, the highest REY and WP (56.60 t/ha and 3.94 kg/m^3) were obtained in Tomato-T.Aus-T.Aman. Total water use was also found higher in this pattern and ranged from 1437 mm to 1780 mm depending on irrigation management. In general, TWU was lower in non-rice dominant pattern than rice dominant pattern. REY and WP were increased drastically when some non-rice crops like tomato, potato, watermelon and even jute were included in the pattern. Among the pattern, the highest gross margin and the BCR (Tk. 649704/ha and 3.21) were obtained from Tomato- Jute-T.Aman under T_4 water management and the lowest values (Tk. 57604/ha and 1.44) were obtained from Wheat-Mung-T.aman cropping sequence under T_2 water management in saline prone area. While in the drought prone area, the highest gross margin and the BCR (Tk. 751102/ha and 4.28) were obtained from Tomato-T.Aus-T.Aman in T_3 water management and the lowest values (Tk. 43520/ha and 1.39) were obtained from Chickpea-Mung-T.aman cropping sequence in T_1 water management. In both the areas, not a particular water management option was suitable for a particular crop and/or cropping sequences for getting higher yield and profit as well. From validation study, it is evident that AFI technology can save about 30% of irrigation water without any sacrificing in yield. Drip irrigation can save about 42% of irrigation water with the increase in watermelon yield by about 30%. Moreover, consumptive use strategy of freshwater and saline water that is, irrigation with fresh water at early growth stage and with saline water at later stages could be practiced realizing good yield of wheat and maize in saline environment.

Upscaling water saving technologies for crop production in Barind area

This upscaling program on water saving technologies in Barind area was initiated from the rabi season of 2016-17 under different cropping patterns by the financial assistance of SDC/DASCOH. The water saving technologies on rabi crop (tomato, mustard, potato, wheat and chickpea) was demonstrated under different treatments in different cropping patterns. The highest marketable yield of tomato was found (61.59 t/ha) with drip irrigation system followed by alternate furrow irrigation (59.67 t/ha) methods and water saved over farmers practice also the highest (45%) in drip irrigation system followed by alternate furrow irrigation method (32.1%). Benefit cost ratio (BCR) was found the highest (2.39) in alternate furrow irrigation system. The higher yield of mustard was found (1.397 t/ha) applying two irrigations and water productivity (1.65) was also higher in the same treatment. Among the treatments alternate furrow irrigation, furrow irrigation and farmers practice, the highest average yield of potato was found 38.41 t/ha in alternate furrow irrigation method followed by furrow irrigation (35.60 t/ha) method and average water productivity (24.08 kg/m^3) was the highest in same method. The percentage of irrigation water also saved in alternate furrow irrigation and in furrow irrigation method was 37.25% and 7.28%, respectively compared to farmers practice. The cultivation of potato is increased day by day in Barind area, so a huge amount of irrigation water can be saved by applying irrigation to the potato field in alternate furrow irrigation method. The yield of wheat applying two irrigations at CRI and grain filling stage and applying three irrigation at CRI, flowering and grain filling stages is almost same, but water productivity of the treatment with two irrigation was highest (2.82) among the three treatments. Yield of chickpea was found higher (1.31 t/ha) applying one irrigation at early vegetative stage. Water productivity (2.16) was also higher in same treatment. The average BCR for tomato cultivation in farmers practice (T_1), furrow irrigation (T_2), alternate furrow irrigation (T_3) and drip irrigation (T_4) method was found 2.32, 3.26, 3.59 and 2.62, respectively. The yield of tomato was highest in drip irrigation method but BCR was not highest due to initial cost for setting of drip irrigation system. On the other hand irrigation water saved by drip irrigation method was about 48% and in alternate furrow irrigation method more than 30% irrigation water was saved. However, gross return obtained under drip system was higher (Tk. 492720/-) than under AFI method (Tk. 478080). BCR is also highest (3.59) in alternate furrow irrigation system. So, drip irrigation and alternate furrow irrigation both may be the suitable option for cultivation of tomato in this area. In mustard cultivation, gross return, gross margin and BCR was found higher by apply two irrigation (T_2) compared to apply one irrigation but water productivity was remarkably higher in T_1 (1.65 kg/m^3) where one irrigation was applied than treatment T_2 (0.93 kg/m^3) where two irrigation was applied. So, considering higher water productivity and the water scarcity situation in Barind area one irrigation at pre-flowering stage is recommended for cultivation of mustard. The gross return, gross margin and Benefit cost ratio for potato cultivation was found highest in alternate furrow irrigation method followed by furrow irrigation method. The gross return, gross margin and BCR was found lowest in farmers practice method. In wheat cultivation BCR was found highest in treatment T_2 applying two irrigations at CRI and grain filling stages. BCR was found highest (3.04) in chickpea by applying one irrigation at early flowering stage. Farmers can get easily additional money Tk. 21,000 to cultivate chickpea in one ha of land by applying only one irrigation. Alternate furrow irrigation (AFI) technology were demonstrated for cultivation of maize at three farmers field of Tanor upazilla of Rajshahi district during the kharif season of 2016-17. Among the treatments alternate furrow irrigation, furrow irrigation and farmers practice, there was no significant yield variation because during the kharif season enough rainfall occurred. Hence, no irrigation was required. The BCR of these treatments were 1.68, 1.69 and 1.65, respectively. Alternate furrow irrigation for cultivation row crops (Tomato, Maize, and Potato) can save 30-35% of irrigation water than the existing use farmers practice method as well as to reduce groundwater abstraction in this area. Secondly, farmers can be benefitted by using less water. Drip irrigation for high value horticultural crops may significantly reduce groundwater abstraction and increase crop water productivity.

PROJECT: Cropping System Intensification in the Salt Affected Coastal Zones of Bangladesh and West Bengal, India

a) Establishment of short duration T. Aman crop for increasing cropping intensity, productivity and gross margin in the salt-affected coastal areas of Bangladesh

The aims of the study is to sustainably increase cropping intensity in the coastal zones of Bangladesh in the dry season through integrated soil, water and crop management. Therefore, the experiments were executed at the ACIAR/KGF project sites of Amtali, Barguna and Dacope, Khulna during kharif-II season of 2016 to increase the intensification of cropping by developing economical cropping patterns using fallow land. The most common and traditional practices of cropping patterns followed in the coastal areas is mainly Fallow-Fallow-Transplanted Aman. Short duration and high yielding T.aman crop variety was tried in the salt-affected coastal zones under ACIAR-KGF project at farmers' field of Sikandorkhali village, Amtali, Barguna and Pankhali, Dacope, Khulna. In 2016, T. Aman crop (BRRI Dhan 62) was tried at farmers' field to improve the productivity of existing cropping pattern by introducing early establishment of short duration new variety as well as higher yield and economic return for the farmers. The experiments were laid out in randomized complete block design with three replications under each farmer. Three farmers were selected at the site of Sikandorkhali, Amtali, Barguna under the polder no 43/1 and two farmers were selected at the site of Pankhali, Dacope, Khulna under the polder no 31. Data were collected through direct field measurement and survey data of the selected farmers. On average, T. Aman (BRRI Dhan 62) crop was harvested 30 to 45 days earlier than traditional varieties although gross margin was lower than local varieties. On an average, the output-input ratio was found lower in T. Aman variety of BRRI Dhan 62 (on average 1.08) than local variety of T. Aman (on average 1.6). This variety might be more profitable by increasing the cultivation of the same or similar type of short duration high yielding variety to the all farmers under the same block of the project site, especially for short duration establishment- of T. Aman rice crops for growing three crops in a year instead of one crop per year in the salt affected areas of coastal zone in Bangladesh.

b) Conjunctive use of fresh and saline water irrigation for sunflower in coastal areas of Bangladesh

Conjunctive use of fresh (non-saline: pond water) and saline water (medium saline: canal water) for irrigation is a strategy to irrigate rabi crops in the coastal salt affected areas of Bangladesh where fresh water is not available. Therefore, the experiments were conducted during 2016-2017 at the farmers' field of the village of Pankhali at Dacope, Khulna and Sikandorkhali at Amtali, Barguna under the ACIAR-KGF project at salt affected coastal regions of Bangladesh. The objectives of this study were (i) to evaluate the effect of soil moisture, salinity, osmotic pressure, pH and plant biomass at different growth stages, (ii) to assess the effect of fresh and saline water irrigation on the crop performances, water use and water productivity and (iii) to find out the scope of saline and fresh water irrigation for sunflower crop cultivation. The experiments were carried out in two farmer's field at Pankhali and three farmers' field with six irrigation treatments and replicated thrice. The treatments were: T_1: 2 IR at vegetative and flowering stage with FW, T_2: 2 IR given at vegetative with FW and flowering stage with SW, T_3: 2 IR given at vegetative with FW and grain filling stage with SW, T_4: 3 IR at vegetative, flowering and grain filling stage with FW, T_5: 3 IR at vegetative with FW and flowering and grain filling stage with SW, T_6:3 IR at vegetative and flowering with FW and grain filling stage with SW. Results showed that the conjunctive use of fresh water at early growth stages and saline water at later growth stages had no significant difference among the treatments at the both locations of Dacope, Khulna and Amtali, Barguna. The trend of soil water contents increased or decreased at mid growing season of crop and decreased from sowing (37%) (December 2016) to harvest (29%) (March 2017) among the treatments in 60 cm profile with 15 cm increments due to proper utilization soil moisture by the plants. Salt accumulation at the end the growing season was not substantially increased among the treatments compared to beginning of the crop season. The highest changes in soil salinity occurred at the end of the growing season on average 9.62 dS/m (February 2017) compared to the beginning of the growing season on average 5.32 dS/m (December 2016) in 60 cm soil profiles. On an average, the osmotic potential ranged in all treatments was -200 kPa to -344 kPa from sowing to harvest, respectively. The changes in soil pH occurred averagely 7.8 to 8.2 in the soil profiles during the growing season. Plant biomass was lower in treatments of T1 and T2 than the treatments of T_4, T_5 and T_6 in both locations. The seed yield of sunflower ranged was found 2.33 to 2.53 t/ha at Dacope and 1.65 to 1.93 t/ha at Amtali. In treatment T_6 produced seed yield of sunflower 2.53 t/ha at Dacope and 1.93 t/ha at Amtali. Seasonal crop water use ranged from 194 mm (T_2) to 249 mm (T_5) with an average of 223 mm at Dacope and from 219 mm (T_2) to 264 mm (T_5) with an average of 248 mm at Amtali. Water productivity of sunflower under different irrigation treatments ranged from 0.94(T_4) to 1.27 kg/m^3 (T_1) with an average of 1.12 kg/m^3 at Dacope and from 0.63 (T_4) to 0.85 kg/m^3 (T_1) with an average of 0.75 kg/m^3 at Amtali. The average water salinity of pond, canal and river at Dacope was monitored and recorded by 1.21, 2.2 and 16.81 dS/m and 0.47, 4.40 and 12.65 dS/m at Amtali at 10 days interval during the crop growing season. Based on obtained optimum yield, water productivity and reducing the risk of soil salinity, osmotic pressure and scarcity of available water, an alternative irrigation scheduled and method can be practiced by the conjunctive use of fresh water (low sanity≤0.5 dS/m) at early crop growth stages and saline water (medium salinity≥1.5-5 dS/m) at later growth stages of crop in coastal saline prone areas of Bangladesh.

c) Cropping pattern based water management for different crops in salinity prone areas of Bangladesh

Cropping pattern based water management is needed to sustain irrigated agriculture to intensify the system productivity in coastal regions of Bangladesh. Therefore, the experiment was conducted during 2016-2017 at the farmers' field of the village of Sikandorkhali at Amtali, Barguna under the ACIAR-KGF project at salt affected coastal regions of Bangladesh. The objectives of this study were (i) to find out the effect of cropping pattern on salinity, crops yield and water productivity, (ii) to evaluate the economics of the cropping systems, (iii) to identify the suitable cropping pattern in terms of water use and profitability and (iv) and demonstrate and popularize the improved cropping pattern and suitable water management practice among the farmers. The experiments were carried out in three farmers' field with recommended irrigation treatments and replicated thrice. The treatments were: (i) CP1: Watermelon -T. Aus (Optional) -T. Aman, (ii) CP2: Sunflower -T. Aus (Optional) -T. Aman, (iii) CP3: Maize -T. Aus (Optional) -T. Aman, (iv) CP4: Wheat – sesame (Optional) –T. Aman, (v) CP5: Fallow-Fallow-T. Aman (Farmers' practice, control). Results showed that the trend of soil water contents decreased at mid growing season (February 2017) of crop from sowing to harvest among the treatments in 60 cm profile with 15 cm increments. Salt accumulation at the mid growing season was substantially changes and soil salinity ranged from 8 to 13 dS/m and highest 13 dS/m in February 2017 compared to the beginning and end of the growing season, respectively in 60 cm soil profiles. Similarly, the osmotic potential was obtained highest -680kpa (on average) during the crop growing season of February 2017. The changes in soil pH ranged from 6.5 to 7.5 among the treatments in the 60 cm soil profiles during the growing season. Results revealed that rice equivalent yields (REY), production efficiency (PE) and total system productivity (TSP) was obtained highest by 6.69 t/ha, 2.72% and 9.08 t/ha, respectively in cropping system of CP3 (Maize-T. aus-T. aman) compared to other cropping patterns. .In terms of crops yield and water use, cropping system CP3 produced highest total system water productivity (4.2) compared to other cropping systems. Gross margin and benefit cost ratio was in the order of CP3 >CP2 >CP4 >CP1> CP5. Based on one year study and in terms of crops yield, rice equivalent yields, total system of crop and water productivity, profitability of economics and reducing the risk of soil salinity, osmotic pressure and scarcity of available water, CP3 (maize-T.aus-T.aman) and CP2 (sunflower-T.aus-T.aman) would be practiced in coastal salinity prone areas of Bangladesh.

11 FMP ENGINEERING

Project I: Conservation Tillage, seeding and Planting Machinery

Adoption of two wheel tractor operated seeder in rice-wheat cropping system

Two wheel tractor (2WT) which is generally called power tiller in Bangladesh. Power tiller operated seeder (PTOS), sometimes called as reduced till seeder and it is being used for different crops seeding along with seed bed preparation. It works as shallow tiling, fertilizing, seeding in line, seed covering and land leveling at a time maintaining the standard agronomic practices. The seeder was demonstrated in different locations in the farmer's field of Dinajpur, Tangail, Barisal, and Rajshahi area in 2016-17. Recommended basal dose fertilizers were broadcasted over the land surface before seeding operation. Improved inclined plate seed meter was used for seeding small to large size seeds. Different plate contains different cell size for convenient planting operation. The metering plates were interchangeable and allow minimum till to change one plate to another. During pulses seeding, TSP was applied along with seeding operation through the machine. Wheat, maize, and lentil were planted after rice harvest and mungbean, sesame planted after wheat harvest. The density of rice residue was 0.9-1.5 t/ha. The seeder performed seeding operation minimizing 7-9 days turn around time utilizing the residual soil moisture. It maintained uniform seeding depth, uniform seed distribution and better seed soil contact which transfer soil moisture to seeds quickly for enhance better plant establishment and yield. Average wheat yield was 18.2-22.5% higher than conventional method. Effective field capacity was 0.13 ha/h. Cost of wheat seeding was Tk. 1950/ha which was 65.8% less than conventional method (Tk.5695.0/ha). Long term on station trial (8 years), wheat yield in minimum tillage by PTOS showed higher than conventional planting system in rice-wheat-mungbean crop rotation maintaining 30% crop residue. No yield reduction trend observed over the time compare to conventional method. Every year, about 100 units seeder introduced in the farmer's field. There are about 1170 numbers of active seeders now in the country.

Adoption of two wheel tractor operated bed planter for upland crops

Adaptive trials of two wheel tractor operated bed planter were conducted in the farmers' field of Rajshahi, Gazipur, and Barisal areas in 2016-17. The bed planter was improved and fine tuned with the introduction of operator's seat, attachment of especial size pulley for increasing rotary speed and introduction of improved inclined plate seed metering device for planting small to large sizes seeds. The operator could drive the planter in ridding position. It solved the problem of long distance travel and enhance adoption considering the added advantage of easy comfortable operation. The size of pulley was 8.5 inches (216mm). Power transmission chain of the bed planter was divided into two parts avoiding shaking of chain during over come land boundary (aiel). Both the dongfeng and sifeng type bed planter now available. The implement comprised of four major components, namely- rotary tilling part, furrow opener, seeding unit with metering mechanism and bed former-cum-shaper. Performance of the bed planter was tested for wheat, maize, mungbean and rice cultivation. The uniformity of maize seed spacing was 88-95%. The density of rice and wheat residue were 1.8 t/ha and 1.6 t/ha in the tested plot, respectively when seeding on permanent bed. After initially forming the bed, an additional advantage was that reshaped bed could be used for next crop without any further tillage operation keeping it permanent. Fresh bed saved 21.5% and permanent bed saved 34.1%

irrigation water over conventional flood method of irrigation with less number of labour involvements. Water logging problem could be avoided introducing bed planting system, especially in rainy season crops. Bed planting allowed earthing up, so no need of sub sequent earthing up in maize cultivation. Bed planting saved 44% tillage cost compare to conventional method. Maize planting cost in new bed and permanent bed was 63.0% and 72.5% less than conventional seeding method. Average wheat and maize yields were 4.4 t/ha and 9.8 t/ha, respectively. The same wheat and maize yield in conventional method were 3.3 t/ha and 9.3 t/ha, respectively. Yield advantage of wheat and maize were was 33% and 5.4% over conventional method. Long term on station trial (7 years), wheat yield under bed planting showed higher than conventional planting system in rice-wheat-mungbean crop rotation maintaining 30% crop residue. Net return for wheat cultivation in fresh bed and permanent bed planting were 1.7 times and 1.5 times than conventional method. The bed planter was using as custom hire basis in the farmers field. There were about 6325 ha lands under bed planting system.

On farm validation of two wheel tractor operated zero till planter for upland crops

Two wheel tractor (Power tiller) is the common means of soil tillage and other farm operations in Bangladesh due to easy access in fragmented land size with affordable price. The zero till planter is a pull type implement which hitched with tiller at the drawbar point replacing the regular tilling part of it. The validation trials of zero-till planter were conducted in the farmer’s field in Rajshahi areas for wheat, maize, and pulses establishment during 2016-2017 and a field evaluation conducted at Parbotipur, Dinajpur. The planter could pull 4 tynes in soft and medium hard soil but 3 tynes for hard soil. The planter was capable to apply seed and fertilizer in an opening slit of width 30mm and depth 60 mm. Slower speed (2.5 km/h) was comparatively better for seed placement into the opening slit. The planting depth, row spacing and seed rate could be adjusted according to standard practices. Depending on the level of weed situation, round up herbicide was applied 2 days before planting to kill the existing weeds. No till crops showed less lodging tendency compare to conventional planted crops. Zero-till farmers saved plant establishment cost 50-65%, and minimizing the average turn around time 7-9 days between the two crops. The effective area coverage and planting cost by the seeder was 0.12 ha/h and Tk.1900.0/ha, respectively. Long term trial (7 years), zero till wheat yield showed continuously higher than conventional planting system in rice-wheat-mungbean crop rotation maintaining 30% residue. No yield reduction trend was observed over the time. Fertilizer management, weed control and selection of right crop variety with proper crop rotation were the key issue for adopting this new technology.

Evaluation and extension of two wheel tractor operated potato planter in the farmer’s field

A low cost power tiller operated cup type potato planter was improved in Bangladesh Agricultural Research Institute (BARI), Gazipur which could plant whole tuber potato seeds as well as cut piece potato seeds automatically in furrows at predetermined regular intervals. Potato planter maintained a single row of spacing 600 mm and seed to seed distance average 200-250 mm for whole tuber seed and 150-160 mm distance for cut piece seed. Performance of the planter was evaluated in the farmer’s fields to determine the effect of forward speed and seed sizes on the uniformity of spacing and seed missing during 2016-17. Forward speed of 2.4 km/h was the best in respect of uniformity of spacing and missing seeds. Seed sizes of 35mm were found the best in respect of uniformity of spacing (94%) at the speed of 2.4 km/h. Field demonstrations were conducted at on station BARI, Gazipur and in the farmer’s field of Puthia, Paba, Sibpur, Rajshahi. The average effective field capacity of cup type planters was 0.10 ha/h and missing seed was 3%. Potato planter requires 4 man-days/ha compare to 67 man-days/ha in conventional manual planting method. Potato planting cost were Tk.4804/ha. On the other hand, using whole tuber and cut piece seed, manually potato planting cost was Tk.14,740/ha and Tk.16940/ha. Labour requirement for whole tuber seed planting in case of planter and conventional method were 4 man days and 67 man days, respectively. There was no significant yield difference between potato planter and conventional methods. Manufacturers and operator trainings were conducted under the project works. Farmers field day was also conducted near the potato field showing the crops condition of mechanically planted plots and conventional planted plots. Potato planter could save labour requirement of 63 man-days/ha and planting cost Tk. 9936/ha which was equivalent to 94% and 67% saving of labour and planting cost, respectively compare to conventional manual potato planting method.

Design and development of a 4 wheel tractor operated seeder for cereal crops

A 4 wheel tractor operated seeder was designed and developed for direct seeding of cereal seeds, such as rice, wheat, soybean, mugbean, mustard, dhaincha etc. Fluted type seed metering device was used. The seeder was fabricated with locally available iron materials in the workshop of Wheat Research Centre, BARI, Nashipur, Dinajpur during 2016-2017. It was connected with the roller through chain and sprocket system. When the tractor moved forward, rotavator till the land, the roller rotated and the power was transmitted from the roller via the chain and sprocket to the seed. Rotavator was dismantled from the assembly, the 4 wheels tractor operated seeder also might be used as a zero tillage cultivator. Thus it could act as conservation agricultural machinery. Wheat seed was sown by the seeder and germination rate of the wheat seed was 90%.

Design and development of a manually operated multi-crop vegetable seedling transplanter

Bangladesh is a notable grower of vegetables. From marginal to affluent farmers, all depend on hand and hoe for vegetable seedling transplantation. Bangladesh resides fragmented, smaller land holdings. The basic requirements for small scale cropping machines are, they should be suitable for small farms, simple in design & technology and versatile for use in different farm operations. Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur has designed and developed a manually operated multi-crop vegetable seedling transplanter during 2016-17. Seedlings of variable age and different size could be transplanted at variable spacing. It could save time, increase cropping intensity, help in seed/fertilizer placement and it was made of durable and cheap material affordable for the small scale peasant farmers. The operating, adjusting and maintaining principles was simple but for effective handling it needed skill operator.

Project II: Inter Cultural Operation and Irrigation Implement

Development of a low cost battery operated rotary type weeder for up-land crop

Weeds are considered undesirable plant in agriculture and gardening. The process of removal of weeds from crops is called weeding. Weeders are mechanical machines which are used for weed removal. A rotary type DC motor operated dry land weeder was designed, developed and evaluated which was cost effective and environment friendly. Chemical method of weed control was more prominent than manual and mechanical methods. However, its adverse effects on the environment were making farmers to consider and accept mechanical methods of weed control. The mechanical weeder was to reduce drudgery and cost which ensured a comfortable posture of the farmer or operator during weeding and increase production. The costs associated with mechanical weeding such as operating cost could be lowered; as such mechanical weeding could represent a viable and cost effective option to majority of medium and small scale farmers in developing countries like Bangladesh. A 3D model of weeder was designed by Solid work 2015 software and fabricated considering methodological steps.

Design and development of a low cost boom sprayer for fruit tree and field crops

A low cost robust power operated tri-cycle garden boom sprayer had been developed in Farm Machinery & Postharvest Process Engineering Division of BARI Gazipur and all set up installed on a tri-cycle van 2015. It had been further improved with flexible boom which allowed to spray in tall fruit trees and evaluated 2016-17 for mango and litchi trees. Farmers were interested in horticultural crops for high value, comparatively low risk, less hazard, and easy marketing of product compare to field crops. Crop yields were reduced mainly due to attack of pests, diseases and weeds. The developed boom sprayer consists of small diesel engine, high pressure pump, pesticide tank, boom with nozzle, and tri-cycle. The chemicals were sprayed as the most effective and efficient techniques for applying small volume of spray liquid to protect horticultural crops. The boom sprayer was tested for spraying pesticide in fruit trees to produce uniform effective spray pattern using minimum amount of spray materials. The spray boom had hollow nozzle and could spray in tall tree. The effective field capacity of the sprayer was 0.3 ha/h. The field performance of the boom sprayer was found satisfactory at a pressure of 3 bars. The average spray capacity 2.85 lit/min at 3 bar pressure. The power requirement about 4 kW for operating the pump. Operating cost of garden boom sprayer was Tk. 595/day and foot sprayer was Tk.1029/day, respectively. The entire boom assembly fixed on a rickshaw van behind of the operator seat. It was safe in adverse wind condition. To facilitate convenience operation for the operator, the design of the entire controls provided near the operator. A transparent plastic tank was provided for clear view of pesticide status in the tank.

Project III: Harvesting Machinery

Development of a low cost two wheel tractor operated potato harvester

A low cost two wheel tractor driven potato harvester had been developed and improved with locally available materials in Farm Machinery & Postharvest Process Engineering Division of BARI, Gazipur to facilitate small farmers to harvest their potatoes at low cost. The developed potato harvester was a semi automatic digging machine consisting of (i) digging blade (ii) conveyer flat chain (iii) Guide plate and (iv) Power transmission arrangement with a dimension of 900 mm x 850 mm x 950 mm. The potato harvester was demonstrated in the farmers field of Rajshahi, Tangial, Rangpur and in the TCRC potato farm in 2016-17. The field capacity of the potato harvester covers daily average 1.2 ha land depending on operator skillness. Potato harvester required labour 21 per ha only instead of 60 labours per ha in traditional manual method. Total cost of potato harvesting by the potato harvester was Tk. 9,835 per ha but manually harvesting cost was Tk.23,600 per ha. Potato harvester saved 58.3% potato harvesting cost and 65% labour requirement compare to traditional manual potato harvesting method. Moreover, there were no potatoes remain under the soil. Potato damage percentage was less than 1.21%. Potato farmers always pass risk of bad weather especially harvesting time. So, potato harvester could cover large areas within short period of time, escaped bad weather uncertainty, and sustained potato production stable. Manufacturers started producing the potato harvester and sell to the potato growers. One unit of this harvester had been given to CIP, India through MoA.

Modification and performance evaluation of a mango harvester

Mango harvester is mainly used for harvesting mango fruits with less drudgery, fatigue on labour, also preventing damage to the tree branches & fruits as compared to manual plucking and tree shaking. A mango harvester was designed and fabricated at Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur during 2014-15. The weight of aluminium mango harvester was 4.1 kg whereas it was reduced to 2 kg during 2015-16 and 1.7 kg during 2016-2017. Weight of modified bamboo harvester was 1.7 kg during 2015-16and 2.1kg during 2016-17. The weight of previous model bamboo harvester was 1.5 kg. The mango was harvested from different heighted mango trees in different location of BARI campus, Gazipur during 2016-2017. The highest capacity of modified aluminium and modified bamboo harvester was found to be 222 kg/h and 156 kg/h. When mangoes were harvested by aluminium harvester, 4% of mangoes were found with pedicel length below 1-1.5 cm, whereas it was 5% for modified bamboo harvester. Overall efficiency of the aluminium and modified bamboo harvester was found to be 95%. For previous model bamboo harvester, overall efficiency was found to be 70 %. The initial cost of aluminium harvester was Tk. 5800 and it reduced to Tk. 2200 during 2015-16.The initial cost of modified bamboo harvester was Tk.1100 and previous model bamboo harvester was Tk.450. During this year cutting blade of harvester was set at the upper side of the ring which facilitates the operator to observe the position of mango during cutting operation that makes harvesting operation easy for operator.Using this harvester, pulling operation and cutting at a point of mangos, both operations were possible if necessary.

Design and development of coconut tree climber

Coconut tree climber is a machine which enables to climb on coconut tree without much human efforts. Now a days most of the human activities are either replaced by the use of machines or other kind of equipments. Coconut tree climber was developed at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur. Different persons were taken with different height, weight and age during operation. Before and after climbing up a tree operators blood pressure data was taken for ergonomic evaluation. The highest speed of machine during climbing up a tree was 10.72 m/min when the height of the tree was 8.90 m and the highest speed of climber machine during climbing down from a tree was 8.06 m/min. The price of the machine was about 6500 Tk and harvesting cost per tree was 20Tk.

Project IV: Postharvest Machinery

Development of a low cost two wheel tractor mounted mobile maize sheller

Power tiller (Two wheel tractor) is a very common tillage tool in Bangladesh. A low cost simple power tiller front mounted spike tooth type mobile maize sheller had been developed at Farm Machinery & Postharvest Process Engineering Division of BARI, Gazipur 2015 and it was evaluated in the farmers field in 2016-17 with a view to easy way shelling maize in rural areas and eliminating botheration of transportation of traditional maize sheller from place to place. The main components of the sheller were hopper, rotating cylinder, concave, grain delivery out let, shelled cob delivery out let, sheller fixing arrangement, main pulley with power transmission arrangement. It was an anti clockwise rotating cylinder, axial flow type sheller and grain separated with a frictional force between spike tooth and concave. The maize sheller was attached with nuts and bolts in front of the engine base of two wheel tractor (2WT). The operating power of the sheller came from the fly wheel of the engine of the tractor through ‘V” belt pulley arrangement. The average shelling capacity of the mobile sheller was 2.1 t/h, broken kernel 2.1%, and shelling efficiency 97%. The average cost of shelling maize was Tk. 0.22/ka compare to traditional custom hire rate Tk.1.0/kg. The service provider of the two wheel tractor could transport the mobile maize sheller long distance in operator’s seating position as it attached with the 2WT which minimized transportation hazard of maize sheller.

Improvement of existing BARI maize sheller for shelling unhusked maize cobs

Hand peeling of maize is common practice before shelling which is laborious and time consuming. An improved BARI maize sheller was designed during 2014-15 and was fabricated during 2015-2016 in Farm Machinery & Postharvest Process Engineering Division, BARI, Gazipur so that both peeling and shelling can be done in the same machine. During 2016-2017, some modification had been done such as fabrication of husk outlet, modification of frame and reducing gear size for roller gap adjustment. This machine had two part in which peeling was done in upper part and husked cobs were delivered to lower part for shelling. Two rubber and two spiral rollers were used for peeling of cobs. After peeling operation dehusked maize cobs was delivered to the shelling part of the maize through the outlet of peeling part. During 2016-17, data of peeling maize cob was taken at the moisture content of 20%-24% because shelling operation was done within this rang of moisture content of maize grain. Last year, the machine was tested and peeling data was taken at the moisture content of 24%-34% of maize cobs. The peeling capacities were found 900 kg/h -1227 kg/h when the moisture content of maize cobs were varies from 20%-24%.The peeling capacities of the manual and power peelings were 87kg/h and 1054 kg/h respectively at 22% moisture content of maize cobs. During peeling operation it was observed that 1% of grains were injured and 3.2 % of maize cobs were found unhusked which was very negligible. The efficiency of the machine was found to be 95.8%.The average engine and machine speeds were 1281 and 351 rpm respectively. While operation of the machine, rubber rollers were stopped to move which reduced the capacity of the machine. This problem would be eliminated by adjusting the alignment of the spiral and rubber rollers. Shelling part of the machine will be fabricated in the next year.

Development of AC powered solar pump for surface water irrigation

Solar pump is gaining popular worldwide because the power is environment friendly and renewable in nature. A 750 W centrifugal type DC motor operated solar pump was fabricated at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur during 2016-17. The size of both the suction and delivery pipe was 51.0 mm. The pump was directly coupled with a 3-phase induction motor (DC). The input power was 1200 W_p/3000 VA (max) and input voltage was 200 V_{ac} (line to line). The DC power was converted with a 1000 VA inverter. Average solar radiation, voltage and current were found 350 W/m^2 188.87 V and 3.34 A, respectively during testing of pump. Maximum discharge was found to be 266.22 L/min at the suction head of 1.30 m. Minimum discharge of 87.56 L/min was found at the suction head of 4.80 m. The average discharge was obtained 170.89 L/min. The DC motor operated solar pump may be used for surface water irrigation in Bangladesh.

Improvement and performance evaluation of a mini oil expeller

A mini oil expeller was designed and fabricated at the workshop of the Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during the period of 2016-2017. Overall dimension of the expeller 1200×570×1280 mm and power required to operate the machine was 12.5 hp diesel engine. Four kilograms of mustard was expelled per batch. The average engine and machine speeds were 1500 and 15 rpm, respectively. Average oil recovery was 35.0%. The expelling capacity for mustard was 12.0 kg/h. The main problem of previous mini oil was that it was stucked during operation. The problem was solved in the improvement of the present oil mill. The improved oil mill ran smoothly during operation. The oil mill may be operated by power tiller engine and it should be movable. Then the machine need to be demonstrated in the farmers' field for its dissemination.

Appropriate conservation machinery for rice based cropping pattern in the southern delta of Bangladesh

The field experiment was conducted at Mundopasa, Ujirpur, Barisal and Regional Agricultyral Research Station (RARS), Rahmatpur, Barisal as control field during rabi season of 2017 for testing, adoption and popularization of different conservation machinery such as zero till planting method (ZT), strip till planting method (ST), bed planting method (BP) and PTOS method along with conventional tilling and of sowing method. The tested crop was mungbean (BARI Mung-6). The cutting depth from soil for ZT, ST, BP, PTOS and power tiller were 2.76, 4.89, 11.30, 5.71 and 7.40 cm respectively. The top width of bed of BP method and strip width of ST method were found 26.60 cm and 6.08 cm respectively. The effective field capacity of ZT, ST, BP, PTOS and power tiller were found to be 0.097, 0.104, 0.082, 0.111, and 0.081 ha/h, respectively. The fuel consumptions for operation of all machines were similar except power tiller. ZT, ST, BP, PTOS saved about 60% fuel than power tiller. Significantly the highest grain yields were found from zero till and strip till planting methods both on-station and on-farm conditions. Significantly the lowest grain yield was found from conventional tillage and planting method. Farmers were interested to grow mungbean using conservation machinery. Therefore, strip till and zero till planting of mungbean may be popularized in Barisal area.

Design and development of a low cost power driven tomato and potato grader

Potato and tomato are sold without grading in the markets of Bangladesh. Since mechanical graders are not available, potatoes are graded, manually. Grading potato tubers by size in these countries, especially for seed, is done by hand, which is time-consuming and costly. A rotating cylinder type tomato and potato grader was developed in Farm Machinery and Postharvest Process Engineering Division (FMPE), Bangladesh Agricultural Research Institute (BARI) in 2016-2017. The overall dimension of the tomato and potato grader was 3070mm×690mm×1150mm. The grader was made of locally available MS angle bar, MS flat bar, MS rod, MS sheet, MS shaft, ball-bearing, V-belt, V-pulley, and chain-sprocket etc. A 1 hp electric motor was used to rotate cylinder at 17 rpm. Four graded of potato and tomato was obtained from the grader through four outlets of three cylinders. In first tray, it observed that injury percentage increased with the increase of rpm of cylinder for tamato and potato. In second tray, injury was vise versa for tamato but for pomato as it tray one. In third tray, there was no relation among them. There were some problem identified during laboratory test where the injury rate was high. Grader will be modified for cherry tomato and injury will be reduced in next year.

Development of a mechanical vegetable washing machine

On the basis of farmers' demands of selected project areas -Pabna and Jessore, a higher capacity root crop washing machine was designed and fabricated at Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur during July to December 2016. The overall dimension of the machine was 2200 × 910 × 920 mm. It was fabricated with MS sheet, MS flat bar, nylon shaft, brush, MS shaft, FL bearing, chain-sprocket, wheel, motor, gear reducer, magnetic contact, and Off-On switch etc. The main parts of it are: i) Half circle tank; ii) Nylon brush roller; iii) Power transmission system; and iv) delivery chute. The rollers were rotated by an electrical motor of 2.2 kW at 1400 rpm. Per batch 120 kg carrots were washed using the machine and 6-7 minute washing time was required for each batch. The capacity of the machine is 0.90 kg per hour. No injured carrots were observed. The washing efficiency of the machine was found to be 98%. The price of the machine is Tk. 1.8 lac. The weight of the machine was 418 kg. The washing cost was 340 Tk./ton. The machine can save about 500 Tk/ton which was equivalent to 66% saving of washing cost compare to conventional manual carrot washing method. Break-even point of the root crop washing machine was 270 h/yr. Therefore, there was a good opportunity for farmers and traders to increase income and generate employment using the machine.

Modification of a hot water treatment plant for fruits

A simple and less electricity requirement hot water treatment plant for mango was designed and fabricatied with stainless steel (SS) materials in the Farm Machinery & Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur in 2016.When fruits are treated by the machine, water temperature decreased from 55°C to 53°C within 10 minutes. This temperature was not recommended for treating mango. Therefore, treating operation was stopped up to 10-15 minute but heaters are running. Later water temperature was raised up to 55°C within 15 minutes. To minimize the breakdown of the operation of machine, heating power was increased from 12 kW to 18 kW for continuous operation of the machine. An electric motor of 0.38 kW was used for rotation of conveyor roller and stirrer, and six electric immersion heaters of 3 kW were used. It is expected that the improved plant would be better performance to treat mango continuously without stopping the machine. The price of the plant was 1,70,000 (US$2200).

Development of a power coconut dehusker

Coconut produced about 0.37 million tons in Bangladesh. Husk of coconut is removed for getting nut and shell as raw materials in coconut oil industries and for edible purposes in household level. Husking is done manually by sharp iron in oil industries and retail markets in our country. The work is hard and required high skill and strength. The study was undertaken to develop a power coconut husking machine for dehusking coconut easy and quickly. This study was conducted at Farm Machinery and Postharvest Process engineering Division, Gazipur during 2016-2017. It was made of locally available MS (mild steel) materials. The overall dimension was 910×690×1130 mm. Functional parts of the machine were main frame, power transmission system, dehusking unit and electric motor. Dehusking unit consisted of two rotating spike roller made of galvanized iron (GI) pipe along with some spikes. An electrical motor of 2.24 kW was used as a prime mover. Motor rpm was stepped down from 1450 to145 by means of gear reducer (ratio: 1:10). Operating speeds of the drive and driven spike rollers were 28 rpm and 18 rpm respectively. Weight of the machine was 250 kg. The capacity of the machine ranged from 250 to 313 coconuts per hour. The husking efficiency was 97 percent. Capacity of the machine was about two times more of the traditional husking. The breakage of nuts was found to be 7.78 per-cents. Operating cost of coconut was 400 Tk per 1000 nuts. Price of the machine was 6,20,000 Tk. The machine would be useful for commercial purpose in coconut oil industry, wholesale and retail market for shelling coconuts.

Design and development of a cashewnut sheller

The most laborious part of the cashew nut processing is the shelling or removal of outer shell of cashew nut. It also has some health implications due to the corrosive action of cashew nut shell liquid on human skin. A vertical disc type sheller was designed and tested at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute (BARI), Gazipur during 2014-15. Shelling performance and whole kernel recovery percentage were found very poor. So the sheller had been redesigned and fabricatedusing different principle to improve the performance. Using locally available materialsa splitter type sheller was fabricated. The clearance between the blades was adjustable so that it could shell the cashew nut of any grade. The sheller was tested with little amount of preserved sample and the sheller would be tested systematically after harvest this year.

Preparation of maize stalk fodder for cattle

Shortage of feed supply of the cattle during the dry season is an important issue which could be partially meet by maize stalk. An experiment was conducted to prepare maize stalk fodder for cattle. The BARI chopper was improved for chopping maize stalk in smaller size (7-8mm). Total chopping cost per hour was 0.21 taka per kg. The chopped maize stalk in both fresh and dried condition with different combinations were fed to the cattle. Smaller sized chopped piece of both dried and fresh maize stalk could be fed in both raw mode and mixing with slat, wheat bran and water with little molasses. Maize stalk block also prepared with different combinations and found that block made by liquid *Gur* was better in both physically and cattle likeness. Total cost of block per kg was 13.85, 31.35, 28.85 and 36.35 Taka for MS block 1, MS block 2, MS block 3 and MS block 4, respectively. Further study will be conducted to develop the chopper for increasing capacity and reducing price, and to follow up storability of the chopped maize stalk and liking behavior by the cattle

Project V: Renewable Energy

Determination of technological options for biogas production from crop residues

The research aims to increase the biogas potential of straw by using various pretreatment processes as well as to produce biogas from crop residues through anaerobic digestion. Among lignocellulosic materials from the agricultural sector, straw is considered to have the biggest potential as a biofuel and therefore also represents a big potential for biogas production. However, the degradation of lignocellulosic materials is somewhat restricted due to the high content of lignin that binds cellulose and hemicellulose and makes them unavailable for microbial degradation. Consequently, low methane yields are achieved. Various technological options like pretreatments of fodder can be considered to increase the rate of breakdown of this lignocellulose complex. This experiment consists of two distinct phases which combinedly executed the desired aim. One phase was to design and development of a biogas plant and the other was pretreatment of agricultural residues. In this experiment paddy straw was chopped in smaller size of 2~3 cm and after hydrolysis of 48 hours it was incubated with *Trichoderma herzianum* fungi for different time intervals. Chemical analysis was done to check for digestability. A small scale biogas plant was designed and fabricated at the workshop of Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2016-17. Various tests were conducted to check its suitability as an anaerobic digester. Biogas production was ongoing and the experiment would be continued to the next year for better performance.

Project VI: Collaborative Programmme

Technical back up to manufacturers for machinery prototype development and fine tuning of existing machines

Group meeting and orientation of technical staff of machinery manufacturers were conducted for improve understanding about seeding implements in FMPE Division, BARI Gazipur 2016-17. Flute type seed metering dye produced by the local manufacture successfully and inclined plate seed metering device dye also produced in Rajsahahi. Relationship between researchers and manufacturers improved which reflect in machinery production. Progressive farmers need to close contact with manufacturers for display machinery product and feedback collection. A Saifeng type bed planter had been developed under this programme in Rajshahi. Manufacturers were able to understand technical functioning components of the implements. Manufacturers showed interested in fabrication BARI mobile maize sheller and potato harvester.

Design and establishment of a 'tillage-cum-seeding laboratory' at the FMPE division for advanced farm machinery research

Intensifying cropping on fallow lands during dry winter season is challenged by predominantly clay soils that retain excess post-monsoon season soil moisture in southern Bangladesh. Use of conventional machinery to repetitively till and manually establish crops can delay dry season sowing by days or weeks, precluding timely crop establishment and exposing crops to late-season soil salinity, terminal heat, flash floods, and other risks. Two-wheeled tractors with attachable rotavators were used for strip-tillage by removing some of the tillage blades which allows rapid single-pass strip-till furrow formation and crop establishment. Current practice of using commercially available bent or straight C blades operated at the depth of 50–60 mm however results in either excessive soil throwing (with bent blades) or an incomplete furrow (with straight blades) in the excessively moist clay soil condition. Both result in poor seed coverage, increased seed predation, reduced germination and suboptimal plant stands. This study aimed to improve seedbed furrow quality in the moist clay soils (moisture content of 28.2%, bulk density 1.44 gcm^{-1}). We tested three blade designs (conventional, medium and straight) at 50–100 mm depths in a soil bin. The blades (4 blades/row providing a cutting width of 50 mm and rotor diameter of 342 mm) were operated at 480 rpm and a forward speed of 0.4 ms^{-1}. Both blade design and operating depth significantly affected seedbed furrow depth, width, backfill (loose soil remaining in the furrow after strip-tillage), and production of optimum clods (1–20 mm) and unwanted fines (<1 mm). While none of the blades could produce enough backfill at the cutting depth of 50 mm, use of greater depths produced sufficient backfill only in case of the straight blades. Irrespective of the cutting depth, the all the blades produced a high percentage of optimum clods, but a low percentage of fines. We consequently recommend use of straight blades (slightly longer to provide a rotor diameter of 420–450 mm) and an operating depth of 75–100 mm so that the rotor or blade holders do not touch the ground or hinder residue flows.

Adoption and Profitability of BARI Potato Varieties at Farm Level in Northern Region of Bangladesh

The study was conducted in three potato growing areas in northern districts of Bangladesh namely Rajshahi, Rangpur and Thakurgaon during 2016-17 to assess the level of adoption, profitability, farmers' attitude towards the cultivation of BARI released potato varieties and to explore the constraints to potato cultivation. The findings of the study revealed that 59% potato areas were covered by BARI Alu-7 variety, BARI Alu-1314%, BARI Alu-25 14% and BARI Alu-8 12% and the rest 1% areas were covered by local varieties. Adoption level of sowing date, seed rate, gypsum and boron were found high in the study areas. The adoption levels of urea, TSP, MoP were over used and adoption level of cowdung and zinc sulphate were found medium. Only 37% farmers used potato seeds from their own source. Mostly one and two times earthing up, 5-8 times insecticides application and 1-4 times irrigation were practiced by the farmers. Per hectare total cost of BARI released potato cultivation was Tk. 204003 and variable cost was Tk. 161033. The major share of cost was seed (31%) followed by fertilizer (13%) and land use cost (11%). Per hectare average yield of potato was 28 ton with gross returns Tk. 249819 and gross margin Tk. 88786. The net return of potato cultivation was Tk. 45816 per hectare. The benefit cost ratios were 1.22 and 1.54 on full cost and variable cost basis. Infestation of insect and diseases, non-availability of quality seed, high price of seed and inadequate storage facilities were the major constraints to potato cultivation. Sixty four percent farmers were willingness to increase their potato cultivation areas in the next year.

Impact of Mechanization on Technical Efficiency: The Case Study of Wheat Farmers in Northern Bangladesh

The study analysed the impact of mechanization inputs and cultivation systems on productivity and technical efficiency (TE) of wheat in northern part of Bangladesh. A stochastic frontier analysis was used to measure the TE and two methods in each cultivation stage were assessed. The data analyzed in this study were collected through survey of 150 farmers that covered the crop year of 2016. The results showed that TE of wheat producers has increased significantly as the increase of farm mechanization. There was a great variation in the levels of efficiency, which ranged from 0.08 to 0.99 with a mean of 0.72. The mechanization index ranged from 0.13 to 0.95 showing a high variation in the application of farm machinery for wheat production. The correlation between the mechanization index and TE strongly demonstrated the impact of mechanization on the efficiency of wheat producers. These results have implications for capacity building and continue government support on farm mechanization to increase productivity on wheat farms.

Profitability Analysis of Strawberry Cultivation in Selected Areas of Bangladesh

The study was conducted in Joypurhat and Rajshahi districts to assess the profitability of strawberry cultivation in Bangladesh. A total of 100 strawberry cultivating farmers, taking 50 farmers from each district, were randomly selected for this study. Descriptive statistics was used to analyze data. The Cobb-Douglass production function was used to estimate the coefficients of the various variables analysed. MPP, MVP and resource use efficiency were also used to estimate the efficiency of resources used in strawberry cultivation. Per hectare cost of producing strawberry was estimated as Tk.

8, 65,590. Per hectare net return and BCR from strawberry cultivation were found Tk. 13, 31,362.17 and 2.63 respectively, which indicates strawberry cultivation is highly profitable. Farmers in the study areas performed different value addition activities like cleaning, grading, packaging, labeling and transportation to increase their product price. Efficiency ratio of the inputs indicates, farmers of the study area were not efficient in using inputs and they need training to be efficient. Total estimated postharvest loss at the farmers' level was 12.40% of total production which was 2579.33 kg per hectare. A large number of farmers (65%) mentioned disease infection as a remarkable cause of postharvest loss. About 54% farmers mentioned transportation facilities should be improved to reduce postharvest losses. Highest 37% farmers reported that strawberry plants were attacked by many more diseases. Highest 48% farmers reported that transportation facilities of the study areas were poor. If the shortcomings are overcome, Bangladesh can move towards mass production and cultivation of the fruit, thereby achieving economies of scale and making it a more profitable venture.

Economics of Papaya Production in Some Selected Areas of Bangladesh

The study was conducted to depict the overall economics of papaya cultivation in four districts namely Tangail, Jossere, Bandarban and Rajshahi. The objectives of the study were to examine the cost structure, resource use productivities, profitability and the problems of papaya production. A total of 152 farmers taking 38 from each district were selected randomly. Data were collected through a pre-tested schedule during January-March, 2017. The per hectare use of human labour, plant protection, manures and fertilizer were found to be maximum at Jossere whereas, per hectare use of saplings was found to be maximum at Tangail district. The per hectare cost of cultivation of papaya was high at Jossere (365405) followed by Tangail (Tk. 334261), Rajshahi (Tk. 319754), and Bandarban (Tk. 272664). The average per hectare yield were maximum at Jossere (62MT) followed by Rajshahi (55MT), Tangail (54MT) and Bandarban (52MT). Per hectare gross margin was highest at Tangail (Tk. 802797) followed by Bandarban (Tk. 658441), Jossere (Tk. 536346) and Rajshahi (Tk. 471298). Per hectare net return was highest at Tangail (Tk. 633738) followed by Bandarban (Tk. 507335), Jossere (Tk. 346594) and Rajshahi (Tk. 302747). The overall benefit cost ratio 2.39 which indicates papaya cultivation was a profitable in Bangladesh. The yield of papaya would increase by 0.0407, 0.125, 00.0627, 0.0863 and 0.3785 % if papaya farmers apply 1% additional human labour, seedlings/saplings, fertilizer, dummy for papaya variety, and dummy for soil type. Attacks on viral disease, adverse weather condition, non-availability of reliable pure seed, lack of irrigation facilities, lack of technical knowledge and problems in marketing of papaya were found major constraints of papaya cultivation at farmers' field in the study areas.

Adoption of BARI Mango Varieties and Its Production Technologies by Mango Growers in Chittagong Region

The study was carried out in 28 villages covering 131 mango growers in the selected Upazila's of Hathazari, Fatikchari and Sitakundo in Chittagong District with view to examine the adoption status of BARI mango varieties and its production technologies at farmer's level. Results revealed that out of 11 varieties of BARI mango, the highest rate of adoption was found to be BARI Aam-3 (Amropali) 77% followed by BARI Aam-9 (Kachmitha) 21.2%, BARI Aam-2 (16.6%), BARI Aam-4 (15.1%) and BARI Aam-8 (Rangui) 14.6% irrespective of all locations. But unfortunately it was observed that most of the farmers except well-educated farmers known to BARI Aam-3 as RUPALI Aam. But the rate of adoption of other varieties of BARI Aam was found to be lower. Among the locations, the rate of adoption of BARI Aam-3 (Amropali) was found as higher in Fatikchari areas (93.3%) followed by Sitakundo (80.6%) and Hathazari (57.1%). The rate of adoption of individual production technologies of mango was significantly varied among the farmers. Majority of farmers did not adopt recommended practices as stated in BARI Krishi Projokti Hathboi such as pit size, planting distance, application of manure and fertilizers (dose, time and method), plant growth regulator, pest and diseases management,. Interestingly, majority of farmers had usually practiced pit size (1.4 ft × 1.4 ft× 1.3 ft) as against the recommended size (3ft×3ft×3ft). Similarly, planting distance had adopted 12x11.7 ft as against the recommended distance of 25ft×30ft. About 67.7% of farmers adopted the improved practice such as breaking the inflorescence of mango trees. About 65% per cent of farmers in all locations practiced the improved practice of mulching in their mango orchards. But the rest did not adopt the recommended practices due to unconsciousness. Majority (52%) of farmer did not adopt training and pruning in their mango orchard. The results of Probit regression analysis revealed that the yield of mango variety, training, extension contact, risk taking behavior and willingness to take loan has indeed helped in contributing to the variance in farmers' extent of adoption of BARI mango varieties significantly. Out of these, family size, family type, innovativeness and mass media exposure can be seen as positive indicator for formulating an extension campaign of adopting the BARI mango varieties in the region. Promote training particularly on BARI mango production technologies and ensuring the availability of BARI mango sapling in local nursery, research station and horticulture center and campaign about the variety in mass media could help to increase the rate of adoption of BARI mango in the region.

Adoption Impacts of Conservation Agriculture Technology at Farm Level in Bangladesh

The study was conducted at three *Upazilas* of Rajshahi and Thakurgaon districts, Bangladesh to assess the adoption status and impacts of conservation agriculture (CA) technologies at farm level during January-February, 2017. A total of 405 farmers taking 135 CA technology adopters and 270 non-adopters were selected randomly for this study. The study revealed that CA technology adoption is still going on in the study areas. However, the rates of adoptions of crop residue retention (67%) and crop rotations (38.9%) within two years were much higher compared to minimum tillage (18.6%). The rate of residue retention (68.9%) and suitable crop rotations (34.4%) adoption was also found high in non-adopters areas. The age, innovativeness, and extension contact of the farmers and availability of VMP had significant positive influence on the adoption of CA technologies. CA technology could save human labour up to 34.1%, seed 31.4%, fertilizers 6.14%, pesticides 32.4% and total cost of production up to 9.80% in cultivating lentil, mustard, maize, and wheat. Again, it increased crop yield and net profit up to 28.2% and 460% respectively. Propensity score matching (PSM) methods further confirmed that CA technology adoption had significant impacts on increasing crop yield, reducing variable costs, and increasing adopters' net income. However, the major problems of higher technology adoption in the study areas were non-availability of minimum tillage planter, lack of knowledge and awareness of the farmer, and no/little subsidy provision on planter. Anyway, to overcome these problems to disseminate these technologies in the areas and the other parts of the country, appropriate steps like increasing availability of the planter, providing training on CA methods should be taken.

Impact of Versatile Multi-Crop Planter on Service Providers' Livelihood in Some Selected Areas of Bangladesh

The custom hiring of Versatile Multi-crop Planter (VMP) is profitable at farm level and service providers could improve their livelihood through this machine. Data and information on these aspects are scarce in Bangladesh. Therefore, an attempt was made to conduct this study to assess the seasonal use pattern and profitability of VMP operations, and its impacts on service providers' livelihood. A total of 18 Local Service Providers (LSP) were purposively selected from Rajshahi, Thakurgaon, Mymensingh, and Rajbari districts for this study. The study revealed that LSPs effectively utilized VMP and PT for 4-6 months. They received Tk. 1, 42,434 (with subsidy on VMP) and Tk. 1, 36,134 (without subsidy) per year as net income. The average payback periods were 0.72 and 0.98 years with and without subsidy, respectively. The annual break-even use of VMP is 7.79 ha. The LSPs experienced a considerable increase in their land holdings (8.3%), value of livestock (11.2%), annual income (34.9%), dwelling houses (36.6%), household furniture (19%), and modern amenities (45.5%). The increased incomes were mostly spent on nutritious food, land mortgage, and dwelling house construction. LSPs faced some minor problems such as unable to use this machine in the wetland condition (61%), no seating arrangement on the machine during ploughing (56%), required higher time (50%), farmers' ignorance (44%), and lack of skill driver (17%). Financial support and technical assistance should be made available by the government for LSPs and local manufacturers, redesign this machine with capable to run in wet condition will helps for its higher adoption.

Small Scale Commercial Water Chestnut Cultivation in Jamalpur District: A Profitable Option for Improving Rural Livelihoods through Waterlogged Fallow Land Utilization

A survey study was carried out to assess the existing agronomic practices of water chestnut, its profitability and problems of production in two selected water chestnut cultivated areas of Jamalpur district during 2016-17 cropping season. The majority of the farmers had transplanted their saplings during the second week of June to last week of July. Findings of the study revealed that on an average 66% of the total cost was involved for human labour followed by land use (14%), insecticides (7%) and saplings (3%), respectively. The average yield of water chestnut was found to be 9.77 ton per hectare. The average profit and gross margin was estimated at Tk. 38439 and Tk. 59826 respectively. The production cost of water chestnut/kg was Tk. 9.05 and return was Tk. 12.98. It was also found that all kinds of livelihood assets of the selected farmers increased significantly through commercial water chestnut farming. Lack of scientific production techniques, high infestation of insect pest especially red crab, siltation by river erosion, buyers syndicate and low output price were the major problems in the study areas. Farmers cultivate water chestnut for getting higher profit, maximum use of seasonal waterlogged fallow land and easy growing.

Postharvest Loss Assessment of Jackfruit Marketing under Different Supply Chain in Bangladesh

A remarkable quantity of jackfruit is wasted every year in Bangladesh due to absence of proper handling, processing, storage and adequate transportation in Bangladesh. The study was undertaken in four districts namely Gazipur, Mymensingh, Moulovibazar and Khagrachari to assess the marketing cost, margin, producer's share, and post-harvest losses under different supply chain of jackfruits marketing. A total of 216 sample consisting 100 farmers and 116 traders were interviewed for the present study. The study was conducted during the period of 2016-17. Data were collected from both primary and secondary sources. Only 21% farmers have sole jackfruits garden and highest jackfruits yield was found in 15 years above garden which was an average 0.43 ton/tree. About 67% farmers sell their jackfruits in advance at garden. Five major supply chains were identified by which jackfruits were moved from producer to consumer. Highest marketing cost was found at *bepari* level which was Tk.1857/ton in all area, and highest marketing margin was found at retail level which was Tk.2389/ton and it was vary on different supply chain. Highest post-harvest loss was found in the supply chain-I which was 39.5%. Farm level loss was the highest post-harvest loss in all types of supply chain which was 21.3% of the total loss. The highest economic loss was found in supply chain-I which was Tk.340 crore based on retail price. Multiple linear regression equation showed that total production and distance were found significant and positive relation to the postharvest losses of jackfruit. Squirrel and bat attack (81%), difficult to harvest (78%), insect and pest attack (77%) and lack of irrigation facilities (64%) were the major production problems and low market price (67%), high transportation cost (72%), lack of storage facilities (74%) and handling problem due to overweight (54%) were the major marketing problems found in jackfruits supply chain. For the improvement of supply chain farmer needs jackfruit harvester (75%), producer cooperatives (62%), training (56%) etc. and traders need reasonable floor price (84%), cold storage facilities (76%) and processing plant (71%) for reducing post-harvest losses of jackfruits.

Production, Marketing and Postharvest Loss Assessment of Litchi in Bangladesh

The study was conducted in four districts namely Dinajpur, Pabna, Narayanganj and Khagrachhari during 2016-2017 to estimate profitability, supply chain and postharvest loss of litchi and explore related problems of in the study areas. A total of 160 farmers and 124 traders were selected randomly for the study. Per hectare average cost of litchi cultivation was Tk. 1, 47,746. Per hectare average yield of litchi was 5.0 ton. Per hectare gross return of litchi was Tk. 4,99,853. Per hectare net return from litchi cultivation was Tk. 2, 03, 583. Litchi cultivation was found to be a profitable enterprise in the study areas since the (BCR 2.38), net present value (Tk. 16, 49,648) and internal rate of return (43%) was very high. Five major marketing chains were identified. Marketing costs and marketing margin of Bepari were highest among the intermediaries. The average postharvest losses were estimated to be 11.48% and 9.81% at the farmers' and traders level, respectively. Losses due to disease, insect and bat attack and harvesting loss were main reason for postharvest losses at farm level. On the other hand, the losses of litchi were found highest for urban retailers (2.85%) followed by Beparis (2.43%) and rural retailers (1.95%). At traders' level, these losses occurred due to transportation, sorting and grading, spoilage and delay selling. Total production and distance to the market were positively significant whereas sale price, transportation dummy and packaging dummy were negatively significant to postharvest losses at farm level. Disease and insect infestation, damage of litchi due to sunburn and storm, attack of bird and bat were major production problem for litchi. However, lack of efficient transport and higher cost of transportation were the major marketing problem for litchi. Area expansion under high yielding variety, shifting of area for litchi cultivation and establishing of agro processing industry were the major opportunities for litchi.

Marketing and Value Chain Analysis of Dry Chilli : A Study in Selected Areas of Bangladesh

The study was undertaken to determine marketing system, marketing cost, margin, efficiencies and to examine the value chain aiming to determine the value addition of dry chilli in different steps of marketing channel. Primary data were used for this study. Primary data were collected from Bogra, Serajganj and Comilla districts depending upon the concentration of production and commercially marketing of chilli; and consuming area Dhaka, Rajshahi and Chittagong. Data were analyzed using marketing margin, profit, efficiency ratio, and value addition. Five major marketing channels were identified for domestic produced dry chilli marketing. Channel-3(Farmer→Trader→Commission agent→Retailer→Consumer) was the most important supply chain through which 24% domestic produced chilli reaches to consumers. Per quintal marketing cost of chilli was estimated from Tk. 101.88 to 3921.15 and marketing margin Tk. 777.00 to 12564, respectively for different intermediaries. Marketing margin and profit were the highest in retailer for non-processed chilli and those were the highest with processed chilli in processing industry than those of other intermediaries. Out of five marketing channel, Channel-2 was more efficient than those of other channels. Eight actors like; farmer, local trader, trader, commission agent, wholesaler, processing industry, distributor, retailer and consumer were identified who were involved in the chilli value chain systems. The study revealed that farmer added the highest amount of value Tk. 1790.00 per quintal in non-processed chilli followed by retailers (Tk. 1339.00), Trader (Tk. 1244.00), wholesalers (Tk. 1035.00) and local trader (Tk 777.00), respectively. In the case of processed chilli, processing industry added the highest amount of value and it was Tk.12564 per quintal. Thirteen marketing problem were identified, among them price fluctuation, higher transport cost and lack of loan facilities were the major and common problem for most kinds of intermediaries involved in chilli marketing in Bangladesh. It is therefore, recommended that loan facilities should be provided to the intermediaries and price fluctuation should be kept in reasonable limit by the government intervention. Natural gas and frequent supply of electricity should be ensured to chilli processing industries for continuous production of processed chilli Technologies should be developed for identification and removal of alpha toxin and heavy metal for enhancing export.

Impact of Climate Change on Wheat Production in Some Selected Areas of Bangladesh

The study examines the impact of climate change in wheat production along with an overview of climatic and non-climatic factors by using the survey data of 180 wheat farmers from three different districts of Bangladesh. Amount of urea, amount of seed used and farmers experience were positively significant with wheat production which indicates that with the increase of this variables production will be increased. Different climatic variables have significant negative impact on wheat production in the survey area. The coefficient of temperature effects on Rajshahi wheat production suggests that rise in December temperature would reduce wheat production and converse is also true. On the other hand if the temperature and precipitation in January both increases, the joint climatic impact in wheat production would be significantly negative in Barishal district. At the same time negative coefficient of the January temperature reflects that rise in January temperature significantly reduce wheat production in Jessore district. Wheat following by Jute and T-Aman are the most preferred cropping pattern in the survey areas. BARI Gom 25 and BARI Gom 26 were very much popular among the wheat farmers in the survey area. Irregular rains, drought, reducing the magnitude of winter cold and irregular deep fog are the main climatic factors disturbing wheat production in the selected areas. It also focuses some adaptation strategies and biotic and abiotic ways to mitigate climate change impact on wheat production. Low price, uncertain rain in the harvesting period and profitable alternative crops led 88.33 percent farmers to take decision on not to cultivate wheat in the next year. Though a lot of wheat varieties were available in the market but still farmers searched for such varieties which can compete with other crops in changing climatic situations. In addition, 76.67% of the respondents still want the quality seed. To aggravate wheat production now it is urgent to maintain a good market for the farmers.

Gher Based Agriculture in Southern Areas of Bangladesh: A Socioeconomic Study

The study was conducted on the socioeconomic study of the gher based agriculture at south western region of Bangladesh. Data was collected from 150 farmers from three district namely Bagerhat, Khulna and Satkhira. The study was revealed out the socioeconomic characteristics of the gher farmer, their educational status, economic status, year of experience of farming and financing etc. Maximum farmer was 41-50 years old at study areas and their average year of experience was 9.42 years on vegetable farming at gher dike. Most of the farmer was small farmer and maximum farmer has no or less own land, so they cultivate by leasing other land at very high cost. They sell their fish and vegetable at local market and some are at farm gate and collect market and production related information from the neighbor. In the study areas farmer cultivate different types of fish like golda, bagda, ruhi, katla, tilapia and carps fish in the gher. On the other hand they also cultivate different types of vegetable like tomato, brinjal, radish, bean, bottle gourd, ridge gourd, snake gourd, ladis finger, cabbage, cauliflower, pumpkin, bitter gourd, yard long bean, amaranth, Indian spinach, cucumber, pipper, papaya, banana, ash gourd etc. at gher dike. Though farmer cultivate year round vegetable there was no specific cropping pattern, but cropping was high. Farmer cultivates different vegetable at relay cropping. Most of the farmer full fills their daily necessity foods from gher dike vegetable and fish. It helps farmer for fight against food security.

Determinants and Its Impact of Occupational Shifting and Migration of Farm Labor from Agriculture to Non Agriculture Sector in Some Selected Coastal Areas of Bangladesh

The study was conducted for the identification of the Causes and determinants of agricultural labour shift, as well as agricultural, economic and social impact in three coastal districts namely Borguna, Patuakhali and Bhola. The study revealed that low profit in agricultural activities (87%) were the major cause of labour shift in the non-agricultural sector. Maximum farmers (49 %) shifted their occupation from agriculture to non-agriculture sector within own district**.** At the Place of destination farmers mainly involved in different kinds of occupation. Rickshaw puller (21 %) was the highest percentage among the shifted labour. Cost of production increases was the major Labour shift impact on Agricultural. Age, Education, Family members, Residence distance and Employment opportunity were the significant determinant for labour shift from agricultural to non-agricultural sector.

13 PLANT GENETIC RESOURCES

Exploration and Collection of Plant Genetic Resources during 2016-17

Multicrop exploration and collection programme was undertaken in 31 upazilas of 10 districts in Bangladesh during 2016-17. Five hundred and seventy three (573) germplasm of 62 crops were collected from Rangpur, Kurigram, Mymensingh, Netrokona, Jamalpur, Comilla, Chandpur, Barisal, Patuakhali and Khagrachari.The germplasm were 14 cereals, 41 pulses, 40 oilseeds, 423vegetables, 38 spices, 5 fruits and 12other crops. Samples of germplasm were collected from field, threshing floor, farm store, cultivated habitat, market etc. Seeds, seedlings, fruits from individual plant or population were collected from selected germplasm. Passport data e.g., crops name, collector's number, local/ cultivar name, sample status, collected source, date of collection, village name, union, upazila and district were recorded in passport data form. The samples were registered and conserved in active collection following appropriate procedures.

Exploration and collection of chilli, cucumber and melon germplasm

Exploration and collection programme on germplasm of chilli (*Capsicum frutescens*), cucumber (*Cucumis sativus*) and melon (*Cucumis melo*) was conducted in 17 upazilas of 6 districts in Bangladesh during 2016-17. Eighty seven germplasm of three crops of which 21 chilli, 35 cucumber and 31 were melon. Collection sites were Chandpur, Comilla, Jamalpur, Khagrachari, Mymensingh and Netrokona districts. The germplasm were collected from farmers' field, threshing floor, garden, farm store, market etc. The status of the sample was mostly landraces. The collection samples were seeds, seedlings, fruits from individual plant or population. Passport data e.g., crop name, collector's number, local/ cultivar name, sample source and status, date of collection, village, union, upazila and district names were recorded. The samples were registered in and conserved in active collection of PGRC/BARI following appropriate procedures.

Characterization of bottle gourd germplasm

The experiment was conducted with 72 germplasm of bottle gourd (*Lagenaria siceraria* (Mol) Standl.) during 2016-17. Collected germplasm were multiplied and characterized in PGRC research field. Among the collection 64% germplasm produced pyriform fruits, 26% elongate fruits, 4% oblong fruits, 4% globular and 1% elliptical fruits. Shapes of blossom end of fruits were recorded flattened in 57% germplasm, depressed in 29% fruits, round in 11% and pointed in 3% fruits. Moderate green, dark green, light green, very light green and patchi green fruits were respectively recorded 36, 24, 22, 14 and 4% germplasm. Angular stem shape, straight tendril type, dentate leaf margin, cordate leaf shape, monoecious type sex, white flower, present of fruit pubescence and soft fruit texture were distributed in all the germplasm. Leaf length and leaf width ranged from 23.7 to 32.8 cm and 22.9 to 30.9 cm respectively. Wide ranges were also recorded in inter node length, petiole length, main vine length, number of primary branches, node number at which 1st male and female flower appears. Days to 1st male flowering, first female flowering and range of harvest of edible were 71 to 95, 75 to 105 and 90 to 128 days, respectively. Wide range of variations 17.1 to 54.8 cm was also measured in fruit length at edible matured stage while range of variation was measured 11.3 to 23.0 cm in width of fruit. Individual fruit weight and number fruits ranged from 1.7 to 6.1 kg and 2 to 7/plant, respectively. The highest CV 30.33% was measured in number of fruits per plant and the lowest 5% was in days to 1st male flowering.

Characterization of chilli germplasm

The exprement was conducted in the experimental field of Plant Genetic Resources Centre (PGRC), BARI, Joydebpur, Gazipur, during Rabi season of 2016-17. Eighty two chilli (*Capsicum* spp.) germplasm were included in the experiment. Germplasm produced elongate, almost round, triangular and blocky were 80.49%, 1.22% 17.07% and 1.22% respectively. Blossom end fruit shapes viz. pointed, blunt, sunken and sunken with pointed were respectively in 76.83, 18.29, 2.44, and 2.44% germplasm. Deltoid, ovate and lanceolate leaf shapes were exhibited in the collection. Maximum 89.02% of germplasm exhibited compact growth habit. Corolla colours were recorded light yellow in 92.68% germplasm, yellow in 2.44% germplasm and purple in 4.88% germplasm. Three fruit colours, namely green, deep purple and green with blackish blue at intermediate growth stage of fruit were recorded in the collection. At full maturity, fruit colours turned light red and red. Fruit surfaces found smooth in 2.44% germplasm, semi wrinkled in 85.37%, and wrinkled 12.20% germplasm. According to estimated CV%, highest variation was observed in number of fruits per plant (118.89), followed by yield per plant (108.07%) and plant height (44.73%). In respect of yield per plant, germplasm AMA-37 (202.50g), AMA-128 (148.69g), AMA-73 (98.29g), RAI-259 (95.53g), AMA-240, (87.99g), AMA-349 (86.57g) and AMA-51 (76.42 g)) were potential for direct use as well as and breeding purposes.

Characterization of amaranth germplasm

The experiment was conducted in the filed plot of Plant Genetic Resources Centre of BARI, Gazipur during 2016-17. Forty two germplasm were included in the experiment. Six gerrmplasm were identified as leaf amaranth while 36 were stem amaranth. The germplasm were again stratified into hard (14.29%), medium (4.76%) and soft (80.95%) on the basis of presence of fiber. Qualitative variation was found in branching index, stem and leaf pubescence, leaf shape, leaf margin, terminal inflorescence shape, terminal inflorescence attitude and inflorescence density index**.** Variation in stem pigmentation was recorded green in germplasm of 23.81% and pink or purple-in 76.19% germplasm. In respect of leaf pigmentations, purple color in entire lamina was in 7.14% germplasm while purple color in margin and vein was in 38.10%, normal green in 26.19%, more green shade on purple leaf in 9.52% and more purple shade on green leaf in 16.67% and light green colour in 2.38% germplasm. Germplasm with green petiole was 38.10%, purple petiole in 50.0% and dark purple pertiol in 11.90%. Color of inflorescence was green in 76.19, purple in 19.05 and dark purple in 4.76% germplasm. Seed color was brown in 4.76 and blackin 95.24% germplasm. The estimated co-efficient of variation 34.57% was maximum in length of top lateral branches followed by 33.14 and 32.00% in lateral branche length and terminal inflorescence lateral length respectively. The 1000 seed weight of the collected germplasm varied within 2.45 to 4.5g.

Characterization of brinjal germplasm

The study was conducted at Regional Plant Genetic Resources Centre, Regional Agricultural Research Station, Ishurdi, Pabna during Kharif- I of 2016-17. Seventy eight brinjal germplasm were included in the experiment. Plant growth habits were upright in 74%, intermediate in 23% and prostrate in 3% germplasm. Plant height was recorded “very short”, “short”, “intermediate” and “tall” respectively in 3, 50, 33, 14 and 0% germplasm. In respect of leaf blade length, 26% germplasm were short, 36% intermediate and 38% were found. Leaf bade lobing was found “weak”, “intermediate to strong” and “very strong” in 4, 29, 46 and 21% germplasm. Variations were found in leaf prickles and leaf hair. Among the germplasm corolla colour was observed like “pale violet”, “light violet” “bluish violet” in 24, 48 and 24% germplasm. Germplasm producing “very short fruit” was 4% while germplasm producing “intermediate” and “long” and “very long fruits” were 6, 46, 41 and 3% respectively. Fruit breath was “small” in 6% germplasm, “intermediate” in 14% germplasm, “large” in 77% germplasm. Fruit curvature was straight in 86% germplasm while “slightly curved” “curved” and snake shaped fruits were produced in 6, 3 and 5% germplasm. Fruit colour was “green” “milk white” scarlet red, purple and black in 47, 17, 4, 19 and 13% respectively.

Characterization of chickpea germplasm

The experiment was conducted with 73 chickpea accessions (*Cicer arietinum* L.) at RARS jessore in Rabi season of 2016-17. None of entries showed plant anthocyanin. In respect of growth habit, 67% accessions were spreading and 33% were prostrate type. In leaf type, leaflet size and pod length no variations were noticed. For flower colours, viz, “dark pink” in 48% accessions “light pink” in 51 and white in 1% accession were recorded. Seed colour was brown in 23 (32%), light brown in 17 (23%), dark brown in 19 (26%), redish brown in 5 (7%), grayish brown in 7 (10%), salmon brown in 1 (1%) and yellow brown in 1 (1%) accession. The accession BD 6138 showed the highest number of basal primary branches (5.00), BD 6306 had the highest number of seed per pod, BD 6406 had the highest number of pods per plant (247.6), BD 6300 had the highest seed weight 65.89g per plant and BD 6389 had the highest 100-seed weight 19.10 g. Days to 50% flowering 67 were the lowest in a total of 13 accessions and a total of 6 accessions matured in a minimum of 115 days. Seed weight per plant had the highest CV 37.42% whereas days to maturity had the lowest 0.69%.

Characterization of okra germplasm at Gazipur

The experiment was carried out with 47 germplasm of okra (*Abelmoschus esculentus* L.) at Plant Genetic Resources Centre, Bangladesh Agricultural Research Institute (BARI) Gazipur during 2016-17. Early plant vigor was “Poor” in 20, “good” in 16 and “very good” in 11 germplasm. Three types of plant growth habit namely erect, medium and procumbent were exhibited in 30, 15 and 2 accessions respectively. Low and profused branching habit were in 35 and 12 accessions respectively. Shapes of epicalyx were linear in 97.87% while triangular was in 2.13 accession. All the accessions had green leaves and produced fruits green in colour.

Characterization of okra germplasm at Khagrachari

The experiment started at the Hill Agricultural Research Station, BARI, Khagrachari during in May-2017. Forty two okra*(Abelmoschus esculentus* L. Moench) germplasm included in the experiment. All the accessions showed erect growth habit, green stem, green with red veins leaf color, and green with red patches petal colour. Days to germination of seed ranged from 4 to 10 days. First flowering ranged from 32 to 40 days after planting. Its an ongoing experiment and data collection is on progress.

Characterization of pumpkin germplasm

Seventy acceaions of pumpkin (*Cucurbita moschata*) were characterized at the Plant Genetic Resources Centre of BARI, Gazipur during winter 2016-17. Early plant vigor, plant growth habit and leaf size showed the variability among the accessions. Different types of fruit shape was found among the accessions like globular 54%, flattened 13%, oblong blocky 16% elliptical 14% and elongate form 3%. Accession produced fruits of skin colour light brown in 31%, brown in 19%, deep brown in 24%, light green in 9% and deep green in 7%. Accessions of 84% expressed mottled fruit skin pattern and 16% were uniform. Stem end fruit shape was depressed in 60% accession and flattened was in 40% accession. Same number of accession and fruit shape were observed while recordeing blossom end fruit shape of the collection. Acceesion producing superficial, intermediate, and deep grooved fruits surface were 14, 79 and 7% respectively. Range of Days to 1st male flower were 74-102 and days to 1st female flower were 79-119. The range of fruit length was 12 to 31 cm while fruit breath ranged from 9 to 29 cm. Wide range of TSS% variation 3-9 was recorded in the accessions. Estimated coefficient of variation 68.36% was maximum in yield per plant which followed 48.97% in number of fruit per plant and 35.19% in fruit weight. Sweetness of fruit in accessions BD-10361 (9% TSS), BD-10063 (9% TSS), BD-8391 (8% TSS) and BD-274 (8% TSS) and yield per plant in accession BD-10365 (24.75 kg), BD-232 (24.8 kg), BD-290 (23.84 kg) and BD-10361 (22.2 kg) were assessed as potential charcaters of the collected germplasm.

Characterization of coriander germplasm

The experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during 2016-17. Forty nine coriender (*Coriandrum sativum*) germplasm were included in the study. Qualitative leaf characters e.g., lamina color, leaf margin, leaf margin color, leaf size, petiole length and stem color were varied substabtially in the collection. Color of seeds in the germplasm exhibited cream 46.94%, light brown 51.02%, and others 2.04%. Estimated CV 36.36% was found highest in seed yield per plant and the lowest 1.33 was in days to first green leaf harvest.

Characterization of cucumber germplasm

Thirty three germplasm of cucumber (*Cucumis sativus* L.*)* collected from different parts of Bangladesh were characterized at Plant Genetic Resources Centre, BARI, Gazipur during summer 2017. In IPGIR descriptor two vine colors viz. light green and dark green have been listed. Both the stem colors were observed in the collection. Distribution of germplasm having different stem colors was independent. In the collection three fruit shapes were present and oblong fruit was found to dominate over oval and ovate fruits. In stem end of fruit, obtuse and acute shape were recorded while in blossom end, flat and tapered shapes were observed The descriptive statistics of leaf and fruit characters revealed the existence of substantial variation in the collection. Among the leaf characters, length and width were found to be variable. In fruit characters, high variation was noticed in fruit length, individual fruit weight, number of fruits per plant and fruit width. The highest coefficient of variation 35.72 was found in fruit length followed by 35.14 in fruit weight at edible stage and the lowest coefficient 3.13% was in days to mature fruit harvest.

Characterization of summer muskmelon germplasm

The experiment was carried out with 131 germplasm of muskmelon (*Cucimis melo* L.) at Plant Genetic Resources Centre, BARI, Gazipur during February to June 2016. The germplasm were collected from different districts of Bangladesh. Globular 31%, oblate 31, flattened 18%, elongated 8%, elliptical 6% and ovate shape fruit 5% were recorded in the collection. Ribs on fruit surface were superficial in 43%, intermediate in 14% and deep in 31% were recorded while ribs in fruits of 12% accesion were absent. Light green to dark green fruit skin colour were observed at marketable stage. Skin hardness of fruit was soft, intermediate and hard. The muskmelon exhibited smooth and spongy flesh texture along with white color in 62%, orange color in 33% and green color in 5% flesh. All the germplasm were exhibited very good in early plant vigor, long viny plant growth habit, absent stem pubescence, angular stem shape, coiled and unbranched tendril. Fruit length, fruit breadth and flesh thickness ranged from 9.67 to 32.70 cm, 7 to 23 cm and 11 to 34 mm, respectively. Number of ribs on fruit varied from 3 to 14 and fruit weight varied 0.28 to 2.9 kg. The estimated co-efficient of variations 102.15% was highest in 100-seed weight and the lowest 20.98% was in flesh thickness.

Characterization of summer cucumber germplasm

Thirty seven germplasm of cucumber (*Cucumis sativus L.)*were characterized at Plant Genetic Resources Centre (PGRC), BARI, Gazipur during summer, 2016. The germplasm was collected from different areas of Bangladesh. In qualitative character, Stem colour was light green, dark green and stem pubescence density were medium and dense among the accessions. Variability also showed in different fruit characters i.e stem end fruit shape, fruit shape, fruit skin colour at edible mature stage. Light green and yellowish green fruit skin colour were at edible stage. Whereas brown and yellow fruit skin colour at mature stage found in all accessions. Days to staminate and pistilate flower ranged from 35 to 45 and 43 to 54 days, respectively. Average fruit length and fruit width was 17.86 cm and 7.46 cm, number of fruit per plant was ranged from 3 to 11. Maximum number fruit per plant was obtained from AC-201 and minimum number of fruits per plant was recorded from AHI-15.The highest coefficient of variation in fruit weight at edible stage was 40.85 % followed by 34.15% in number of fruits per plant and lowest 4.05% in days to mature fruit harvest.

Molecular characterization of muskmelon germplasm

The experiment was carried out with 96 germplasm of muskmelon (*Cucumis melo* L.) at Molecular Biology Lab., Plant Genetic Resources Centre of Bangladesh Agricultural Research Institute, Gazipur. An extensive research programme has been initiated with nine microsatellite markers for the estimation of genetic diversity among 96 muskmelon germplasm. High quality genomic DNA was obtained successfully using modified SDS and phenol: chloroform: IAA protocol. All nine microsatellite markers were found to be polymorphic. Variation was found in number of alleles, allele frequency, observed and expected heterozygosity. Using nine primers across 96 genotypes a total of 28 alleles with an average number of 3.11 alleles per locus were found. The locus TJ10 showed the highest number of alleles (5) (size ranging from 141 to 160 bp) followed by 4 alleles (132 to 157 bp and 98 to 113 bp) and 3 alleles (131 to 141 bp, 230 to 302 bp, 150 to 162 bp and 171 to 187 bp) at the loci CMGA104, CMCT44, CMAG59, CMTA134a, and J27, respectively. The primer TJ10 also yielded the highest number of PIC value (0.770). Genetic differentiation (Fst) values were found in the ranges from 0.535 to 1.000 with an average of 0.776 and gene flow (Nm) values ranged from 0.000 to 0.218 with an average of 0.072. Broad genetic base was found among the muskmelon genotypes. Over all Nei's genetic distance value from 0.000 to 2.300 among 4560 pair resulting as a means of permutation combination of 96 muskmelon genotypes. In the UPGMA dendrogram, among 96 genotypes of muskmelon 12 grouped in cluster "A" and other 84 in cluster "B".

Molecular characterization of rapeseed-mustard germplasm using SSR marker

Brassica mustard species represent one of the most important oilseed crops in Bangladesh. A better understanding on their genetic diversity essential for the proper utilization of genotypes in breeding programmes. In this study 25 genotypes were characterized with the help of SSR markers to reveal the genetic diversity among genotypes of oilseed *Brassica* species. These species include *Brassica rapa, B. juncea* and *B. napus*. All 10 microsatellite markers were found to be polymorphic and they produced 34 alleles with an average 3.40 allele per locus. The locus Ni3G04b had the smallest (98-108 bp) and Na12D04 had the largest fragments (275-293 bp). Average observed heterozygosity of SSR markers was 0.321, ranging between 0.000 and 0.522. The PIC values ranged from 0.211 for the locus Ra2E07 to 0.737 for the Na10-D03. Genetic differentiation (Fst) values were found in the ranges 0.532 to 1.000 with an average of 0.752 and gene flow (Nm) values ranged from 0.000 to 0.228 with an average of 0.082. Higher level of genetic differentiation and low level of gene flow values are indicative of diverse genotypes used in this study. Over all Nei's genetic distance and Similarity coefficient values from 0.000 to 2.706 and 0.000 to 1.000 among 299 pair resulting as a means of permutation combination of 25 mustard genotypes. In the UPGMA dendrogram, the total genotypes were distributed into two main clusters (I and II). Cluster I mainly comprised of the *B.rapa* and *B. juncea* genotypes, while most *B. rapa* genotypes grouped in Cluster II.

Molecular cahracterization of mango

Allelic patterns and genetic distances were examined in a collection of 19 genotypes of mango (*Mangifera indica*) including released variety, advance line and commercial cultivar of Bangladesh in order to develop a reference database to support cultivar protection and breeding programs. This experiment was carried out with SSR markers, of the 25 primers screened, 21 primers gave reproducible polymorphic DNA amplification patterns. Variation was found in number of alleles, allele frequency, observed and expected heterozygosity. Using 21 primers across 19 genotypes a total of 80 alleles with an average number of 3.81 alleles per locus were found of which MIAC-6 and MIAC-11 showed the highest number of alleles (6) (size ranging from 244 to 312 bp and 133 to 167 bp, respectively). However, the lowest number of allele (2) with size ranging 237 to 366 bp and 118 to 125 bp observed in the locus MiSHRS-39 and MIAC-11, respectively. The polymorphic information content (PIC values) ranged from 0.349 to 0.781, with a mean value 0.602 for all loci. Of 21 SSR primers, it was identified 13 (61.90%) highly informative (PIC value ≥0.6). The higher level of heterozygosity indicated that greater diversity of genotypes used in the present study. Band patterns corresponding to individual genotype have been identified to discriminate the genotype. The genotypes presented genetic distances between 0.260 and 1.557.The dendrogram generated from UPGMA cluster analysis broadly placed 19 mango genotypes into two major clusters, “A” and “B” in which only one poly-embryonic genotype namely BARI Aam-8 grouped in cluster “B” and other 18 mono-embryonic genotypes grouped in Cluster “A”.

Genomic confirmation of a and c genome of rs lines of *B. Napus* through genome specific ssr markers

Novel basic materials of rapeseed (*Brassica napus* L.) generated via interspecific hybridisations between suitable genotypes of *B. rapa* L. (2n=20, AA) and *B. oleracea* L. (2n=18, CC) represent a valuable source for broadening genetic diversity in oilseed rape (*B. napus*, 2n=38). In this study, Nine varieties from *B. rapa* and one exotic variety of *B. oleracea*var. alboglabra were used as parental materials. Fifteen better performing “Resynthetic” (RS) rapeseed lines of *B. napus* L. (originating from crosses between nine varieties from *B. rapa* and one exotic variety of *B. oleracea*var. alboglabra were studied using Microsatellite (SSR) markers. Two genome specific primers DA for A genome in fragment size (bp) 239 and DC for C genome in fragment size (bp) 625 of *Brassica* used to identify the genomes of 15 RS lines and 10 parental lines. All the 15 RS lines and 9 varieties of *B. rapa* were amplified and produced band in 239 bp except the variety Alboglabra-1 of *B. oleracea* which was implied the presence of fragments for A genome. Nonetheless, the variety Alboglabra-1 of *B. oleracea* and all the RS lines were beared the expected target band (625 bp) only from the species with the genome C except the 9 varieties of *B. rapa* which was indicated the presence of fragments for C genome but not A genome.

Screening of chilli genotypes for drought tolerance at germination and seedling stage

This expriment was carried out to screen 49 (*Capsicum annum* L.) chilli genotypes’ response to drought at germination and seedling stage. These genotypes which were collected from different parts of Bangladesh were screened with osmotic concentration of 12.5% polyethylene glycol 6000 while their respective control treatments were treated using distilled water for fourteen days at germination stage. Relative germination energy, relative germination rate, relative germination index, relative vitality index and the relative PEG injury rate were computed to identify the most tolerant genotypes on germination stage. Genotypes BD-10906, BD-10912, BD-10916 and BD-10913 were found to be the most tolerant. While genotypes RT-29, BD-10902, AM-29, BD-10917, BD-10893 and AHM-46 were the most sensitive to drought. Moreover, an additional study was conducted on 30 days old seedlings to observe their water stress response at their seedling stage. A total of 47 genotypes, 10 genotypes each from tolerant and sensitive; were selected based on the results found at germination stage. After proper watering for 30 days, watering was stopped for the following 10 days. After that, the dead and alive was counted. The seedlings were then re-watered for the following one week and those recovered from dead were counted again. Finally, the dead percentage and recovery percentage was computed as an indicator of water stress tolerance. And the result was very similar to the experiment done on germination stage.

Screening of mungbean germplasm against salinity

An experiment was contacted on screening of mungbean germplasm against different salinity level to identify the moderately tolerant and susceptible mungbean germplasm. Among the ninety two grmplasm none were germinated at 120 mM NaCl salt concentration. Only thirteen germplasm were properly germinated at 80, 40 mM NaCl concentration. Germination percentage were affected by salinity level where higher salinity reduced the germination percentage compared to control. Germination was delayed due increasing salinity lavel. Seedling shoot length and seedling root length were also affected by salinity. Higher shoot length and root length was observed in control then that was lower in 80 mM NaCl concentration. Further study is need to variefy the result and which genotype will perform batter in different salinity level.

Conservation of germplasm in active and base collection

Plant Genetic Resources Centre (PGRC) act as a repository for the BARI mandate crops namely cereals (except rice), pulse, oilseed, vegetables, fruits, spices, tuber crops etc. Six hundred and fifty five germplasm of newly collected, 168 newly assigned accession and 478 existing accessions from regeneration and characterization were conserved in genebank during 2016-17. The accessions were conserved in medium-term storage at + 4 to + 6^0C and long-term storage at -18 to -22^0C. Generally the seeds were dried at 6-8% moisture content before storing. The centre conserving 10,325 accessions of 84 different agro-horticultural crops in the gene bank. Among them, 1760 accessions are cereals, 3529 pulses, 493 oilseeds, 4052 vegetables, 337 spices, 96 fruit and 58 other crops. Viability, quantity and moisture content were checked before conservation of germplasm. An activity chart has prepared and followed to monitor seeds in the bank a cyclic order. Accessions less than 85% viability and/or less quantity of seed are regenerated. Genetic integrity of regenerated seeds monitored by comparing the stacks

Monitoring of germplasm in active and base collection

Germination percent of 488 accessions among 22 crops were tested from active collection those are conserving for 8 years. The viability test was conducted on germination paper for 8 to 21 days during 2016-17. The crops were cereals (wheat, proso millet and teff), pulse (grasspea, mung bean, chickea pea, black gram and field pea), oil seed (linseed), vegetable (grain amaranth, bitter gourd, red amaranth, snake gourd, okra, bottle gourd and pumpkin), spices (sulfa, fenugreek, black cumin and coriander) and jute. Out of 488 accessions, below 40% germination were found in 47 accessions, 40 to 80% germination in 118 accessions and 81 to100% germination in 323 accessions. Similarly, germination percent of 288 accessions of hyacinth bean, pumpkin, ash gourd and bottle gourd were tested from base collection which are conserving for 20 years. Out of 288 accessions, below 40% germination were exhibitd in 59 accessions, 40 to 80% germination in 81 accessions and 81-100% germination in 148 accessions. Seed quantity of 1500 accessions (BD-1 to BD-1600) of wheat, maize, foxtail millet, prosomillet, teff, hyacinth bean, pumpkin, bitter gourd, bottle gourd and ash gourd from active and base collection were monitored. The accessions having germination less than 80% and or less than optimum quantities are slected for regeneration in the next croping seasons.

Distribution of germplasm

Germplasm distribution is one of the important activities of Plant Genetic Resources Centre (PGRC). The centre distributed 1140 accessions of 24 crops during 2016-17. Among them, 247 accessions were cereals (wheat, foxtail millet, sorghum and pearl millet), 221 pulses (grsspea, black gram, lentil and mung bean), 98 oil seed (mustard, sesame and soyabean), 504 vegetables (hyacinth bean, pea, stem amaranth, amaranth, ridge gourd, snake gourd, brinjal, radish, tomato, French bean and okra), 22 chilli and 50 musk melon. Ten to hundred seeds or 5-10 g seed per accession were supplied to the users. The germplasm users were researchers, MS and PhD students, plant breeder, horticulturist and teachers of different Universities and Institutes etc. Contract address and other information of the recepants were recorded.

Regeneration of mustard and safflower germplasm

The regeneration of germplasm was conducted at Plant Genetic Resources Centre, BARI at Joydebpur in Gazipur during 2016-17. Selecting crops as mustard and safflower were successfully grown to perform the regeneration program. Germplasm regeneration leads to get the sufficient seed quantity with increase viability for future use. The most important qualitative characters were recorded to know the variations among the germplasm. *Brassica rapa* and *Brassica juncea* were identified among the 31 germplasm of mustard. Among the germplasm 18 *Brassica rapa and* 13 *Brassica juncea* was found. Crenate and dentate seedling leaf margin; ovate and oblong leaf blade shape in outline; open and erect leaf angle; undulating, constricted between seeds and Smooth siliqua surface outline and red brown, dark brown and yellow seed coat colour were observed. Seven germplasm of safflower (*Carthamutinctorius* L.) were taken for regeneration. The variations were identified for early leaf vigor *e.i* poor, good and very good. All germplasm showed oblanceolate leaf shape, deeply serrate leaf margin, dark green leaf colour and many extent leaf spininess. Predominantly branching habit, conical capitula shape, close OIB attitude and tip and few apical locations of spines on OIB was found. All germplasm showed yellow corolla colour in bloom and deep red corolla colour of dry flower. The pollen production was abundan and pollen colour was found yellow. In case of seed, all germplasm express cream seed colour and conical seed shape.

Regeneration of original sample of fat hen and crown daisy

An experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur, during winter 2016-17 to regenerate the eight germplasmof two crops and those of them was fat hen (*Chenopodium album)*and crown daisy (*Chrysanthemum coronarium)*for future conservation and utilization. In case of fat hen Thegermplasm showed variation in days to 50% flowering, plant height, leaf length, leaf width, leaf colour and 100 seed wieght. Other hand, in case of crown daisy, the germplasm showed variation in days to 50% flowering, plant height, number of branches, flowers/plant, seeds/flower, days to harvest, 100 seed wt and plot yield. On maturity, seeds were cleaned, dried and conserved in the genebank.

Regeneration of spinach germplasm

An experiment was conducted at the Plant Genetic Resources Centre, BARI, Gazipur during winter of 2016-17 to regenerate the 9 newly collected spinach germpalsm. Some of the qualitative and quantitative characters were recorded for using as reference data. Some of variations was also found in the collected materials. Adequate amount of seeds were harvested for conservation and future use.

Regeneration of original sample of sesame germplasm

Thirty one germplasm of sesame were regenerated during kharif-1 season of 2016-17 at the Plant Genetic Resources Centre of BARI, Gazipur to produce sufficient seeds to enrich gene bank. Some qualitative and quantitative data were recorded. Minor qualitative variation was observed among the germplasm. Higher plant height (148.4 cm) was obtained in AMA-194 germplasm than others. The longer (15.36cm) and broader leaves (3.06cm) were noticed in the AMA-286 collected material. The germplasm MAH-16 exposed with higher length (2.78cm) and AMA-365 with higher width (0.74 cm) capsule. Number of seeds/capsule possessed the top position (109.8) incase of AC-513 germplasm. After completing all the post harvest operation, the seeds were conserved properly for future use.

Regeneration of conserved accessions of amaranth

Twenty eight accessions of amaranth (*Amaranthus* spp) were studied at the Plant Genetic Resources Centre of BARI, Gazipur, during winter 2016-17 to regenerate sufficient seeds for future use. Some qualitative and quantitative data were recorded. Wide qualitative variation was noticed among the germplasm. At first, amaranths were categorized on the basis of their use and linking that 2 leaf amaranth, 2 grain amaranth and 24 stem amaranths were identified. Other qualitative variations were also observed in stem pigmentation, petiole pigmentation, leaf pigmentation, leaf shape, inflorescence colour and seed colour. After completing all the post harvest operation, the seeds were conserved properly in the gene bank

Regeneration of conserved foxtail millet and tomato germplasm

Eighty six foxtail millet (*Setaria italica*) and eighteen tomato germplasm regenerated at Plant Genetic Resource Centre, BARI, during winter 2016,-17. Six quantitative data i.e plant height, days to flowering, tiller/ plant, days to harvest, 100 seed weight and seed weight/ plot (g) were recorded for foxtail millet. The germplasm showed variation in plant height, days to harvest, days to flowering, 100 seed weight, tiller/ plant and plot seed weight. Six qualitative data were recorded of tomato germplasm where variation showed in exterior colour of immature fruit, exterior colour of mature fruit, predominant fruit shape and fruit blossom end shape. Adequate amount of foxtail millet and tomato seeds were cleaned, dried and conserved in the genebank.

Regeneration of okra germplasm

The experiment was carried out with 50 germplasm of okra (*Abelmoschus esculentus* L.) at Plant Genetic Resources Centre, Bangladesh Agricultural Research Institute (BARI) Gazipur during kharif season 2016-17 for regeneration. Some qualitative characters were recorded for using reference data. Variations were found in the collected germplasm of okra. Poor, good and very good early plant vigour were found among the germplasm. Erect, medium and procumbent plant growth habit were exhibited. Low and profused branching habit were observed. Linear and triangular shape of epicalyx segments were found among the germplasm.

Conservation of gerplasm in field gene bank

PGRC is maintaining 265 germplasm including 213 accessions of 73 crops both indigenous and exotic germplasm in the field genebank. The fruit germplasm are mango litchi, banana, guava, jackfruit, jujube, aonla, bael, bilimbi, bullocks heart etc. The vegetables germplsm are taro, yam, elephant foot, drumstick etc. The exotic germplasm are rambhutan, pear, tamarind, coffee, passion fruit, dragon fruit and gynura etc. The intercultural practices were done as and when necessary. The field gene bank has been maintained since 1985 and continued for the following years.

Maintenance of germplasm at clonal gene bank of PGRC at Jaintapur, Sylhet

The flowimg 29 germplasm have been maintaining in the clonal gene bank at ARS, Jaintapur, Sylhet since 2008;

Table 1: List of the germplasm in clonal gene bank

Sl. No.	Name of crop	Scientific name	Name of variety	No. of plants
1.	Litchi	*Litchi chinensis*	BARI Lichu -3	04
2.	Guava	*Psidium guajava*	Poly peyera	01
3.	Jackfruit	*Artocarpus heterophyllus*	Graftage	01
4.	Lukluki	*Flacourtia jangomas*	Local	03
5.	Cowa	*Garcinia cowa*	Local	04
6.	Bel	Aegle marmelos	Local	02
7.	Lotkon	Baccuria ramiflora	Local	03
8.	Carambola	*Averrhoa carambola*	Local	09
9.	Indian Olive	*Elaeocarpus floribundus*	Local	02
10.	Jamun	*Syzygium cumini*	Local	03
11.	Taikar	*Garcinia pedunculata*	BARI Taikar-1	03
12.	Sapota	*Achras sapota*	BARI Safeda-1	02
13.	Wax jambu	*Syzygium samarangense*	Local	01
14.	Mandarin	*Citrus reticulata*	BARI Kamala-1	03
15.	Sweet Orange	*Citrus sinensis*	BARI Malta-1	02
16.	Aonla	*Phyllanthus emblica*	BARI Aamloki-1	02
17.	Root stock	*Citrus spp.*	Rough lemon	02
			Rangpur lime	02
18.	Longan (Ashfal)	*Nephelium longana*	BARI Ashfal-1	03
19.	Haritaki	*Terminalia chebula*	Local	04
20.	Bohera	*Terminalia bellirica*	Local	04
21.	Dayfal	*Garcinia xanthochymus*	Local	01
22.	Debdaru	*Polyanlthia longifera*	Local	01

Sl. No.	Name of crop	Scientific name	Name of variety	No. of plants
23.	Bilati gab	*Diospyros discolor*	Local	01
24.	Dewa	*Paleria macrocarpa*	Local	02
25.	Golapjam	*Syzygium jambos*	Local	04
26.	Mahua	*Madhuca indica*	Local	01
27.	Naspati	*Pyrus communis*	Local	02
28.	Monfhal	-	Local	02
29.	Kothbel	*Feronia limonia*	Local	01

In vitro conservation of potato

In vitro conservation of germplasm is one of the objective of Plant Genetic Resources Centre. This is a medium term study of *in vitro* conservation on 8 potato (*Solanum tuberosum* L.) varieties which had been initiated during 2014. The experiment was conducted with 8 varieties of potato at 22^0C to evaluate the performance of *in vitro* conservation. Nodal explants of potato varieties were cultured for 6 months on MS medium. The varieties produced roots within 7 days and shoots within 9 days. Number of leaves (18 to 42), shoots (7 to 21) and roots (6 to 18) were obtained from the varieties. The maximum shoot length (12 cm) was exhibited in BARI Alu-7 and the minimum shoot length (7.0 cm) was obtained from BARI Alu-32.

In vitro conservation of mint

Mint (*Mentha* spp.) is one of the important aromatic plant in Bangladesh. It is a medium term study on *in vitro* conservation at 22 ± 1°C on 3 mint genotypes which had been initiated during 2014. Nodal explants of three mint genotypes viz. MP-1, MP-2 and MP-3 were cultured on MS medium for three months. The maximum number of leaflets (58.1), shoots (7.0), shoot length (10.6), roots (8.0) and root length (3.5 cm) was observed in MP-2.The minimum number of leaflets (36.7) and shoots (3.4) was found in MP-1. While the MP-3 produced the minimum shoot length (7.3cm), root length (3.4 cm) and number of roots (8.0). MP-2 performed better in growth of *in vitro* conservation.

In vitro regeneration of yam

Nodal explants of five yam accessions (*Dioscorea alata*) were cultured for six months at 22 ± 1^0C on MS media to access the influence of two concentration of Kinetin (Kn) with Indol Acetic Acid (IAA) on the production of shoot and root. Five and 10 mg/l concentrations of Kn along with2 mg/l IAA and 3% sucrose were used. The accessions were produced shoots from 16 to 20 days and roots from 12 to 20 days. The maximum number of leaves (21.4) obtained from 5 mg/l Kn and minimum (17.2) from 10 mg/l kn. The maximum shoot length (5.6 cm) was found in 10 mg/l Kn and minimum (4.6 cm) in 5mg/l Kn. The accessions produced 2 to 5 shoots after six months culture. The accessions produced 13 to 15 roots in 5mg/l Kn and 7 to16 roots in 10mg/l Kn. The accession, BD-7853 performed better for shoot proliferation through node culture.

Database development for germplasm documentation

Passport data of 660 germplasm on 63 crops were recorded at the Documentation Laboratory of Plant Genetic Resources Centre during 2016-17. Among them, 14 germplasm were cereals, 41 pulses, 40 oilseeds, 59 spices, 458 vegetables, 2 fruits and 6 other crops. About 30 passport data were recorded on a prescribed passport data form. Characterization data of 558 germplasm were documented. The crops were chickpea, bottle gourd, pumpkin, cucumber, amaranth, brinjal, chilli and coriander. Molecular characterization of 96 musk melon, 25 rapeseed-mustard and 19 mango germplasm were documented. The centre distributed 1140 accessions from 24 crops also documented. All the data were documented as hard and soft copy. Passport informationwere also kept in the local area network of BARI and characterization information are available in FAO web page.

Program Area: Farming System and Adaptive Research

Project I: On-Farm Soil Fertility Management

Development of fertilizer package for potato-maize-T. Aman rice cropping pattern in AEZ-1

The experiment was carried out at MLT, Dinajpur during 2015-16 and 2016-17 to verify the present fertilizer recommendation for Potato-Maize-T.Aman rice cropping pattern. Four treatments viz. T_1 = 100% recommended fertilizer dose based on STB, T_2 = 25% more than T_1, T_3 = T_1+ 3.0 ton poultry manure ha^{-1} and T_4 = Farmers practice (Surveyed) were considered for the experiment to achive the objective. Average soil nutrient status of the experimental plots was pH- 5.16 (highly acidic), organic matter- 1.99 (medium), total nitrogen- 0.10% (low), P- 7.49 µg g^{-1} soil (very low), K- 0.09 meq $100g^{-1}$ soil (low), S- 11.78 µg g^{-1} soil (low). Soil test based fertilizer dose for high yield goal was N_{120}-P_{15}-K_{105}-S_9-Zn_1-B_1 for potato, N_{174}-P_{27}-K_{86}-S_{21}-Zn_1-B_1 for maize and N_{40}-P_8-K_{19}-S_6 kg ha^{-1} for T. Aman rice. The varieties were BARI Alu-7, BARI Hybrid Bhutta-9 and BRRI dhan62 for potato, maize and rice, respectively. The maximum rice equivalent yield was recorded in T_3 which was close to T_2 and the minimum in T_4. REY was increased 26.87% in T_3 and 22.71% in T_2 over T_4. The highest gross return and gross margin were also recorded in T_3 followed by T_2. But the highest benefit cost ratio was obtained from T_2 and the lowest in farmers practice (T_4).

Effect of sulphur, zinc and boron on mustard in charland

An experiment was conducted at stable charland under MLT site Ulipur, Kurigram to study the effect of S, Zn, and B in mustard during 2016-17. The treatments were T_1= soil test based fertilizer, T_2= T_1+25% extra S, T_3= T_1+1.0 kg B ha^{-1}, T_4= T_1 +1.0 kg Zn ha^{-1}, T_5= T_1+25% extra S+1.0 kg B ha^{-1}, T_6= T_1+25% extra S+1.0 kg Zn ha^{-1}, T_7= T_1+1.0 kg B ha^{-1}+1.0 kg Zn ha^{-1}, and T_8= T_1+25% extra S+1.0 kg B ha^{-1}+1.0 kg Zn ha^{-1}. The experiment was laid out in randomized complete block design with 3 replications. The soil test values were pH-5.7 (acidic) OM-1.49 (low) N = 0.08% (low), P = 5.25 µg g^{-1} soil (very low), K = 0.18 meq $100g^{-1}$ soil (low), S = 8.6 µg g^{-1} soil (low), Zn = 0.34 µg g^{-1} soil (low), B = 0.19 µg g^{-1} soil (low). Seeds of BARI Sarisha-14 were broadcasted on 24 November, 2016 and harvested on 08 February, 2017. Among the fertilizer combinations, STB fertilizer with additional S, Zn and B gave the maximum seed yield (1496.67 kg ha^{-1}) which was at par with STB fertilizer with additional Zn and B (1456.66 kg ha^{-1}). The lowest seed yield (1183.33 kg ha^{-1}) was obtained from only STB fertilizer treatment. The highest gross margin (Tk. 59839 ha^{-1}) was found in STB fertilizer with additional S, Zn and B treatment and the lowest in only STB fertilizer treatment. Thus, it was found that additional fertilizer especially micronutrient may enhance seed yield of mustard in stable charland situation.

Effect of ash as a source of potassium and silica on maize

The experiment was conducted at stable charland of Gobindaganj, Gaibandha during the Rabi season of 2016-17 to observe the response of rice husk ash as a source of K and silica on grain yield of maize. Different treatments viz. recommended fertilizer (RF), RF+25% extra K, RF+1.0 t ash ha^{-1}, RF+ 1.50 t ash ha^{-1} and absolute control were tested on commercial hybrid maize variety Miracle maintaining RCB design. Incorporation of rice husk ash plus recommended fertilizer resulted slightly better performance in yield and yield traits but insignificant in this experiment. Recommended fertilizer with 25% extra K produced the highest grain yield (8.78 t ha^{-1}) and consequently, the highest gross margin (Tk. 90219 ha^{-1}) was found in recommended fertilizer with 25% extra K and these were lowest in absolute control treatment. Thus, it was found that additional K fertilizer may enhance grain yield of maize in stable charland.

Effect of spacing and fertilizer levels on onion in charland ecosystem

An experiment was conducted at stable charland under MLT site Ulipur, Kurigram during 2016-17 to find out the optimum spacing along with fertilzer package for onion. Soil test based fertilizer (STB) was verified with different combination of chemical fertilizer with different planting spacing. Six combinations of spacing's and fertilizer were used for the experiment viz, T_1=15cm ×10cm+STB Fertilizer, T_2=10cm × 7.5cm+STB fertilizer, T_3=10cm × 7.5 cm+25% higher of STB fertilizer, T_4=10cm × 5cm+STB, T_5=10cm × 5cm+25% higher of STB and T_6=Farmers practice (5cm × 5cm). The experiment was laid out in RCB design with 3 replications. The soil test values were pH-6.3 (acidic) OM-0.99 (very low) N = 0.07% (very low), P = 12.3 μg g^{-1} soil (medium), K = 0.37 meq 100g^{-1} soil (high), S = 62.8 μg g^{-1} soil (high), Zn = 0.61 μg g^{-1} soil (low), B = 0.37 μg g^{-1} soil (low). Forty five days old seedling of BARI Piaj-1 was planted on 29 December, 2016 and crop harvesting was done 13 April, 2017. Among the treatments, STB fertilizer with 25% additional fertilizer in combination with 10cm × 5cm planting spacing gave maximum bulb yield (9.66 t ha^{-1}) followed by 10cm × 7.5 cm + STB fertilizer (9.33 t ha^{-1}). The highest gross margin (Tk. 49400 ha^{-1}) was found in 10cm × 5cm+25% higher of STB treatment and the lowest one in farmers practice.

Effect of split application of n and k fertilizer on maize in the charland ecosystem

An experiment was carried out at stable charland of Gobindaganj, Gaibandha during the Rabi season of 2016-17 to determine the proper application system and optimum doses of N and K fertilizer for boosting maize production. Different treatments i.e. soil test base fertilizer (STB), STB with additional 15% N and K in two split and also STB with additional 30% N and K in three split application were tested on commercial hybrid maize variety (var. Miracle) maintaining randomized complete block design. The STB fertilizer with 30% extra N and K produced the highest grain yield (9.32 t ha^{-1}) followed by STB with 15% extra N and K (8.93 t ha^{-1}). Size, grain number and grain wt per cob is more in additional 30% N and K plot than others. The highest gross margin (Tk. 98254 ha^{-1}) was found in STB fertilizer with 30% extra N and K and the lowest in STB treatment. Thus, it was found that additional N and K fertilizer in 3 split application may enhance grain yield of maize in stable charland condition.

Effect of ash as a source of potassium and silica on yield of wheat under heat stress environment

The experiment was carried out at FSRD site, Pushpapara, Pabna and Rangpur during the Rabi season of three consecutive years (2014-17) to assess the effect of ash as a source of potassium and silica on yield traits and yield of wheat. The experiment comprised of six different treatments viz. T_1= recommended dose of fertilizer (FRG' 2012), T_2= T_1+25% with extra K, T_3= T_1+1.0 t ash ha^{-1}, T_4= T_1+1.25 t ash ha^{-1}, T_5 = T_1+1.5 t ash ha^{-1} and T_6= control. The BARI Gom-26 was sown 5-17 December during the studied years maintaining seeding rate of 120 kg ha^{-1}. Seed were treated with Provex for controlling seed and soil borne diseases. Field was treated with furadon@10 kg ha^{-1} during final land preparation to control common cutwarm. The highest chlorophyll content (SPAD value) of flag leaf at heading and early grain filling stages was recorded in RF plus all levels of ash and RF plus 25% K whereas only higher levels of ash exhibited significantly higher chlorophyll content at mid grain filling stage. The lowest canopy temperature at heading, early grain filling and mid grain filling stage was recorded in 1.5 ton ash ha^{-1} followed by 1.25 and 1.0 ton ash ha^{-1}. Similarly, the lowest canopy temperature at heading, early grain filling and mid grain filling stage was recorded in 1.5 ton ash ha^{-1} followed by 1.25 and 1.0 ton ash ha^{-1}. Significantly higher grain yield was obtained from all levels of ash plus RF followed by 25% extra K plus RF while lower yield was attained from control.

Maximum economic return in terms of gross return and gross margin was obtained from 1.25 t ash ha^{-1} plus RF both in Pabna and Rangpur. Therefore, incorporation of 1.25 ton ash ha^{-1} plus RF in soil seems to be promising for higher grain yield and economic return of wheat under heat stress environment.

Effect of ash as a source of silica and potassium on maize under drought condition

The experiment was carried out at Farming System Research and Development site, Pushpopara, Pabna during the Rabi season of 2016-17 to assess the effect of ash as a source of potassium and silica on yield components and yield of maize. There were five different treatments viz. T_1 = Well watered (Field capacity)+recommended dose of fertilizer FRG' 2012, T_2 = Water stressed (water withdraw after anthesis)+RF, T_3=T_2+20% extra K, T_4=T_2+1.0 ton ash ha^{-1} and T_5=T_2+1.5 ton ash ha^{-1} were tested on NK-40 variety of maize. The seeds were sown on December 06, 2016 maintaining 60cm × 20cm spacing. Significantly higher yield (11.73 t ha^{-1}) was obtained from well watered + RF which was statistically similar to water stressed + 1.5 ton ash ha^{-1} applied plots whereas the lowest yield (10.92 t ha^{-1}) was obtained from water stressed +RF. Therefore, incorporation of 1.5 ton ash ha^{-1} in soil with recommended dose of fertilizers may help the crop to overcome drought stressed condition.

Effect of ash for yield improvement and minimizing pest infestation in garlic

The trial was conducted at MLT site, Atghoria, Pabna during the Rabi season of 2016-17 to assess the effect of ash as a source of potassium and silica on yield traits and yield of garlic. Different treatment combinations viz. T_1 = Recommended fertilizer dose based on FRG 2012 (RF), T_2 = T_1 + 3 ton ash ha^{-1}, T_3 = T_1 + 5 ton ash ha^{-1}, T_4 = Farmer's management were tested on local garlic variety. The seeds were sown on November 11, 2016 maintaining 15cm 10cm spacing. Significantly highest bulb yield was obtained from 5 t ash ha^{-1} + RF compared to recommended fertilizer dose and as well as farmer's management. Maximum economic return in terms of gross return and gross margin was obtained from 5 t ash ha-1 plus RF which was followed by 3 t ash ha-1 plus RF. Therefore, incorporation of 3-5 ton ash ha-1 plus RF in soil seems promising for higher bulb yield and economic return of garlic. Prevalence of pest and diseases was not observed at significant level.

Integrated nutrient management for spinach

The experiment was carried out at ARS, Pabna during the Rabi season of 2016-17 to assess the effect of cowdung as organic fertilizer on yield traits and yield of spinach. Different treatments viz. T_1 = absolute control, T_2 = Recommend dose of chemical fertilizer (RD), T_3 = 10% of N from organic fertilizer + IPNS basis inorganic fertilizer, T_4 = 20% of N from organic fertilizer + IPNS basis inorganic fertilize, T_5= 30% of N from organic fertilizer + IPNS basis inorganic fertilizer and T_6= 40% of N from organic fertilizer + IPNS basis inorganic fertilizer were tested on spinach (local variety). The seeds were sown on December 07, 2016 maintaining line to line 30 cm distance with continuous seeding. Higher spinach yield (16.67 t ha^{-1}) was obtained from 40% of N from organic fertilizer + IPNS basis inorganic fertilizer which was statistically similar to all other treatments except control. Maximum economic benefit in terms of gross return (Tk. 333400 ha^{-1}) and gross margin (Tk. 241594 ha^{-1}) both were attained from 40% of N from organic fertilizer + IPNS basis inorganic fertilizer.

Soil amendment with rice husk ash for raising quality seedling of vegetables

The experiment was conducted at Agricultural Research Station, Pabna during the Rabi season of 2016-17 to assess the response of rice husk ash on different vegetable seedlings. Four fertilizer packages viz. T_1= Recommended fertilizer management (RF), T_2= RF + rice husk ash 1.0 ton ha^{-1}, T_3= RF + rice husk ash 1.5 ton ha^{-1} and T_4= RF + rice husk ash 2.0 ton ha^{-1} were tested on raising tomato and cauliflower seedlings. The variety of tomato and cauliflower was BARI Tomato-14 and Atlas-70, respectively. The seeds of both vegetables were sown on November 13, 2016. Higher level of ash along with recommended fertilizer exhibited better and healthy seedlings of tomato and cauliflower. Rice husk ash exerted significantly higher chlorophyll content (SPAD value) of leaves in both vegetable seedlings whereas the lowest chlorophyll content was noted in ash omission treatment. The result exhibited significantly higher fresh and dry weight of leaves, stem and root of seedlings under higher levels of rice husk ash treatments for both the vegetables while only recommended fertilizer showed poor performance on the traits.

Effect of ash on potato cultivation

The experiment was carried out at FSRD site, Pushpapara, Pabna during the Rabi season of 2016-17 to assess the effect of ash as a source of potassium and silica on yield traits and yield of potato. Different treatments viz. T_1 = Recommended dose of fertilizer (RF), $T_2 = T_1$ + 1.0 ton ash ha^{-1}, $T_3 = T_1$ + 1.5 ton ash ha^{-1}, $T_4 = T_1$ + 2.0 ton ash ha^{-1}, $T_5= T_1$ + 2.5 ton ash ha^{-1}were tested on BARI Alu-7. The seeds were sown on December 04, 2016 maintaining 60cm 25cm spacing between two rows and from tuber to tuber and the crop was harvested on March 05, 2017. Significantly higher tuber yield (29.95 t ha^{-1}) was obtained from T_3 that was at par with T_2. Maximum economic return in terms of gross return and gross margin was obtained from T_3 which was followed by T_2. Therefore, incorporation of 1.0-1.5 ton ash ha^{-1} plus RF in soil seems to be promising for higher tuber yield and economic return of potato.

Effect of ash as a source of silica and potassium on mustard

The experiment was conducted at MLT site Atghoria, Pabna during the Rabi season of 2015-16 and 2016-17 to asses the response of rice husk ash on seed yield of mustard. Five treatment combination viz. T_1= recommeded fertilizer (RF), T_2= RF + 1.0 ton ash ha^{-1}, T_3=RF + 1.5 ton ash ha^{-1}, T_4=RF + 2.0 ton ash ha^{-1}and T_5=RF+ commercial fungicide were used. The soil test values were pH-8.2 (alkaline) OM-1.93 (low) N = 0.11% (low), P = 5.6 µg g^{-1} soil (very low), K = 0.16 meq 100g^{-1} soil (low), S = 8.8 µg g^{-1} soil (low), Zn = 1.79 µg g^{-1} soil (optimum). BARI Sarisha-14, a popular short duration variety, was sown on 16 November, 2016 and harvested on February 10-11, 2017. Ash exhibited significant influence on yield contributing characters and yield of mustard in both the years except 1000 seed weight. The highest number of siliqua plant^{-1} was obtained from while the lowest number of siliqua plant^{-1} was observed in T_1. With little variation, all levels of ash demonstrated significantly higher number of seeds siliqua^{-1} in the study years. Maximum seed yield was obtained from T_4 and T_3 followed by T_2 whereas the lowest seed yield was noted in T_1. However, the highest seed yield of mustard under T_4 treatment might be the cumulative effect of better performed yield contributing traits.

Effect of ash as a source of silica and potassium on lentil

The experiment was conducted at MLT site Atghoria, Pabna during the Rabi season of 2015-16 and 2016-17 to ascertain the response of rice husk ash on lentil. The experiment consisted of five treatments viz., T_1= Recommended fertilizer (RF) as per FRG, 2012, T_2= RF + 1.0 ton ash ha^{-1}, T_3= RF +1.5 ton ash ha^{-1}, T_4= RF+2.0 ton ash ha^{-1}and T_5= RF + commercial fungicide (Rovral). The BARI Masur-7 were broadcasted in the experimental plot on November 5-7 during two consecutive years maintaining the seed rate 40 kg ha^{-1}. The RF plus incorporation of relatively higher levels of rice husk ash as well as RF plus commercial fungicide application resulted in better performance in yield traits and seed yield of lentil while only recommended fertilizer showed the lowest seed yield. Relatively lower prevalence of stemphylum blight was also investigated under ash amended plot in lentil.

Development of fertilizer recommendation for chilli at charland of Jamalpur

An experiment was carried out at MLT site, Melandah, Jamalpur during October, 2015 to February, 2017 to develop a fertilizer package for chilli. Local variety (Balijori morich) was used in the study. Five treatments were included in this study viz. T_1 = Recommended dose of chemical fertilizers (RD):100-65-100-32-2.0 kg N-P-K-S-B ha^{-1}, T_2 = Soil test based fertilizer dose (STB): 93-51-58-16-0.9 kg N-P-K-S-B ha^{-1}, T_3 = 125% STB based fertilizer dose (116-64-73-20-1.13 kg N-P-K-S-B ha^{-1}), T_4 = Integrated plant nutrient system (IPNS):70-44-47-17-0.9 kg N-P-K-S-B ha^{-1}) based fertilizer dose + 5 t cowdung ha^{-1}, T_5 = Farmers' practice (73-40-50-14 kg N-P-K-S ha^{-1}). The highest dry yield of chilli 4.51 and 4.45 t ha^{-1} were recorded using from IPNS based fertilizer dose+5 t CD ha^{-1} while, the lowest dry yield 2.67 and 2.68 t ha^{-1} was obtained from farmers' practice in 2015-16 and 2016-17, respectively. The highest gross return (445000 Tk ha^{-1}), gross margin (251447 Tk ha^{-1}) and benefit cost ratio (2.26) were also found from from the same treatment (IPNS based fertilizer dose+5 t CD ha^{-1}). The lowest gross return (267000 Tk ha^{-1}), gross margin (71307 Tk ha^{-1}) and benefit cost ratio (1.36) was from farmers' practice

Effect of nitrogen fertilizer on the yield of bottle gourd for leaf purpose

An experiment was conducted in the farmers' field at FSRD site, Elenga, Tangail during Rabi season of 2015-16 and 2016-17 to find out an optimum dose of nitrogen and best method of its application to maximize leaf yield of bottle gourd and farmers' income in Tangail region. The treatment comprised of three nitrogen levels (N_1= 60 kg N ha^{-1} (75%), N_2= 80 kg N ha^{-1} (100%) and N_3= 100 kg N ha^{-1} (125%) and two application methods (M_1= One third of N applied at 2-3 leaf stage and the rest in equal splits after each cut and M_2= Full dose after each cut in equal splits at 5 times). The land was fertilized with 5 t ha^{-1} cowdung and 48-60-28-2-2.1 kg P-K-S-Zn-B ha^{-1}, respectively. Half of K and entire cow dung, P, S, Zn and B were applied during final land preparation. The remaining K was applied in four splits after each harvest of twigs at the time of nitrogen fertilizer application. The seeds were sown on 13 to 18 October, 2016. The twigs were harvested for five times at 12-15 days interval. Harvesting was started from 35 days after sowing (DAS) and it was continued upto 95 DAS.Leaf was infected by leaf blight and it was successfully controlled by using *Ridomil Gold* @ 2 g/L water. Among the treatments combinations the highest twig yield (54.94 t ha^{-1}) and gross margin (Tk. 1058541 ha^{-1}) was obtained from M_1 method along with the highest level of nitrogen (N_3=100 kg N ha^{-1}).

Effect of ipns-based fertilizer on sesame in char land areas

An experiment was conducted at char land under MLT site, Bhuapur, Tangail of AEZ-8 during Kharif 2016 to find out the proper nutrient management packages for BARI Til-4 in char land and farmers income. Three fertilizer doses viz T_1: 107-39-32-17-3.6-0.6 kg, N-P-K-S-Zn-B ha^{-1} (soil test basis), T_2:37-20-16-13-2-1(IPNS with 5 ton cowdung ha^{-1}) and T_3:18-8-18-0-0-0 (Farmers practice). Initial soil was analysed at onset of the experiment. The soil was low fertile. The chemical properties of soil was pH- 6.97, OM-1.48%, N- 0.067%, P = 4.39 μg g^{-1} soil (very low), K = 0.181 meq $100g^{-1}$ soil (low), S = 15.46 μg g^{-1} soil (low), Zn = 0.49 μg g^{-1} soil (low). The seeds of BARI Til-4 were sown maintaining 30 cm line to line spacing during 20 April, 2016. The crop was harvested on 18 July, 2016. Among the treatments, T_1 gave the highest seed yield (1.36 t ha^{-1}) which was at par with T_2 and lowest one (0.92 t ha^{-1}) from T_3 (farmers practice).

Fertilizer management of lentil at charland area of Bhuapur, Tangail

An experiment was conducted at char lands under MLT site, Bhuapur, Tangail during Rabi 2015-16 and 2016-17 to find out optimum fertilizer package for BARI Masur-6 under farmers' field condition. Five fertilizer packages viz. T_1: 24-32-30-18-0.4 kg, N-P-K-S-B ha^{-1} (Based on HYG, FRG' 2012), T_2: 21-17-20-0-0 kg, N-P-K-S-B ha^{-1} (based on PRC, BARI). T_3: 26-35-20-12-0.3 kgN-P-K-S-B ha^{-1} (Based on STB) T_4: Farmers practice (17-8-19-14-0 kg N-P-K-S-Zn ha^{-1}) and T_5: Native fertility were considered as treatments. The seeds were sown on first week of November maintaining 30 cm × 5 cm spacing with seed rate of 35 kg ha^{-1}. The crop was harvested on first week of March. From the average two-year results the T_3 (based on soil test basis) gave the highest seed yield (1.44 t ha^{-1}) followed by T_2 (1.315 t ha^{-1}), T_1 (1.20 t ha^{-1}) and lowest yield (0.78 t ha^{-1}) from T_5 treatment. The highest gross return (Tk. 100800 ha^{-1}) and gross margin (Tk.69971 ha^{-1}) were recorded in T_3. The lowest gross return (Tk. 54250 ha^{-1}) and gross margin (Tk. 29125 ha^{-1}) were found in the control plot.

Effect of biochar on the yield of maize

The experiment was executed at the farmer's field of Trishal upazila under Mymensingh district of Bangladesh during 2016-17 to find out a suitable fertilizer package for maximizing the yield of maize. For this purpose the experiment was laid out in a randomized complete block design consisting of four treatments viz. T_1= Soil test based fertilizer dose, T_2= STB+5 t cow dung ha^{-1}, T_3= STB+10 t biochar ha^{-1} and T_4= Farmers practice (345-25-62-10-1 kg, N-P-K-S-Zn ha^{-1}) were tested with four replication. Soil test based fertilizer dose was calculated as 136-30-50-24-4 kg, N-P-K-S-B ha^{-1}. The experimental soil was silty loam to silty clay loam of the medium highland under the agro-ecological zone-9 (AEZ-9). The soil was acidic (pH 5.0) and low in organic matter (1.39%) and total N (0.074%). Except K soil P and Zn contents were above the critical level and S and B were as of flat to critical level (critical levels of K, P, S, Zn and B were 0.12 meq/100 ml and 7.0, 10.0, 0.2 and 0.6, respectively). The BARI Hybrid Bhutta-9 was sown on November 28, 2016 maintaining the spacing 60cm × 25cm. The unit plot size was 5m × 4m. The crop was harvested on April 30, 2017. Significantly the highest grain yield (9.07 t ha^{-1}) was obtained from soil test based fertilizer dose plus biochar combination while the lowest one (7.43 t ha^{-1}) was found in farmers practice. Maximum economic benefit in terms of gross return (Tk. 149060 ha^{-1}) and gross margin (Tk. 84266 ha^{-1}) was found in STB plus biochar combination treatment. Thus, it was found that in addition of biochar application may enhance grain yield of maize in farmers' field condition.

Effect of organic manures on the yield and quality of potato

The effect of organic manure and chemical fertilizers on potato production was studied at the farmer's field of Shamgonj, Netrakona during 2015-16 and 2016-17. The soil was slightly acidic (pH 6.4) and low in organic matter (1.07%) and total N (0.056%). The soil P, K, S, Zn and B contents were above the critical level (critical levels of K, P, S, Zn and B were 0.12 meq/100 ml and 7.0, 10.0, 0.6 and 0.2, respectively). Five levels of fertilizers including farmer's practice viz. T_1= RFD + 5.0 t cow dung ha^{-1}, T_2= RFD + 3.0 t poultry manure ha^{-1}, T_3= RFD + 1.5 t vermicompost ha^{-1}, T_4= RFD + 10.0 t biochar ha^{-1} and T_5= Farmers' practice (80-20-75 kg N-P-K ha^{-1}) were tested. The recommended dose of fertilizer 135-25-135-15-6-1 kg N-P-K-S-Zn and B was applied evenly all over the plot as a blanket. The unit plot size was 4m × 3m. Application of organic manure in combination with chemical fertilizers had significant effect on yield parameters and yield of potato. The biochar combined with chemical fertilizer gave the highest avrage potato yield (22.50 t ha^{-1}) which was 73% higher yield over farmers' practice when the lowest yield (12.99 t ha^{-1}) was recorded from FP. The highest gross return (Tk. 360000 ha^{-1}) and gross margin (Tk. 210258 ha^{-1}) were also obtained from T_4 treatment. The highest benefit cost ratio (2.40) was obtained from biochar treated treatment. From the study it has been observed that application of biochar is an agronomically viable and economically profitable practice for farmer.

Effect of kitchen waste compost and vermi-compost in combination with chemical fertilizer on the production of summer bottle gourd at char land of jamalpur

An experiment was carried out to know the effect of vermicompost and kitchen waste compost on summer bottle gourd at the Farming System Research and Development (FSRD) site, Kushumhati, Sherpur during 2016. Four treatments were included in the study viz., T_1=Recommended dose of chemical fertilizers (RD), T_2=1.5 t vermicompost ha^{-1}+2/3rd RD, T_3= 3.0 t kitchen waste ha^{-1}+2/3rd RD and T_4= Farmers' practice. The seeds of BARI Lau-4 were sown in the pit on March 31, 2016. The crop was harvested on June 16, 2016 and continued up to July 9, 2016. Results clearly indicated that application of vermicompost and kitchen waste compost significantly influenced summer bottle gourd production. A wide range of variation was also observed among the treatment combinations. The highest fruit yield (31.67 t ha^{-1}) was recorded from 1.5 t vermicompost ha^{-1}+2/3rd RD and lowest yield (18.85 t ha^{-1}) was obtained from farmers' practice. The highest gross margin (Tk. 173575 ha^{-1}) and benefit cost ratio (2.56) were also obtained from 1.5 t vermicompost ha^{-1}+2/3rd RD.

Effect of organic compost in combination with chemical fertilizer on the yield of brinjal under charland ecosystem of Jamalpur

An experiment was carried out at the multi-location testing site, Malancha, Melandah, Jamalpur during 2015-16 and 2016-17 to known the effect of vermicompost and kitchen waste compost on brinjal. The local variety (Bottle begun) was used in the study. Four treatments viz. T_1=Recommended dose of Chemical fertilizers (RD), T_2=Vermicompost 1.5 t ha^{-1} + $^2/_3{}^{rd}$ RD, T_3= Kitchen waste 3 t ha^{-1} + $^2/_3{}^{rd}$ RD and T_4= Farmers' practice were used in the study. The seeds of brinjal were sown in the seed bed on early October. Seedlings were transplanted in the main field on mid November. The unit plot size was 1m × 5m accommodating 20 plants in each plot having 50 cm × 50 cm plant spacing. Fruit harvest started on late December and continued up to March in each year. Both type of compost in combination with chemical fertilizer produced significantly higher yield of brinjal compared to recommended dose of chemical fertilizers only. Vermicompost performed better than kitchen waste compost as produced significantly higher yield. Vermicompost 1.5 t ha^{-1} along with $2/3^{rd}$ of recommended doses of fertilizers provided the highest yield of brinjal and economic return as well.

Validation of biofertilizer on lentil at jamalpur

An experiment was carried out to find out a suitable fertilizer combination for lentil at char land of Jamalpur Rabi 2016-17. BARI Masur-6 was used in the study. Three treatments were included in the study those were as T_1= only chemical fertilizer of PKSZn, T_2=with rhizobium inoculant+PKSZn, and T_3= only chemical fertilizer of NPKSZn. BARI RLc-104 was used as rhizobium strain. The result indicated that grain yield of lentil was increased due to biofertilizer application. The highest grain yield (1.94 t ha^{-1}) was found in rhizobium inoculants + PKSZn and lowest seed yield (1.08 t ha^{-1}) was recorded when it was grown only chemical fertilizer of PKSZn. The highest gross return (Tk. 158320 ha^{-1}) as well as gross margin (Tk. 114991 ha^{-1}) was found in rhizobium inoculant + PKSZn.

Validation of fertilizer management formukhikachu at charlands of Jamalpur

An experiment was carried out to validate of fertilizer management on mukhikachu at the Multi-Location testing site, Malancha, Melandah, Jamalpur during 2016 to verify the fertilizer dose for *mukhikachu* in farmer's field. BARI Mukhikachu-1 (Bilashi) was used in the study. Three treatments were included in the study these were, T_1= 96-27-81-18 kg ha^{-1} NPKS as per FRG'2012, T_2= 120-34-101-23 kg ha^{-1}NPKS (25% higher), T3= Farmers' practice (112-20-50-9 kg ha^{-1}NPKS). The seeds of mukhikachu were sown on March 06, 2016. The unit plot size was 5m × 3.6m having 60 cm × 30 cm plant spacing. The crop was harvested on August 11, 2016. Results clearly indicated that 120-34-101-23 kg ha^{-1} NPKS (25% higher) significantly influenced mukhikachu production. A wide range of variation was observed among the treatment combinations. The highest yield (27.49 t ha^{-1}) was recorded from T_2=120-34-101-23 kg ha^{-1} NPKS (25% higher) and lowest yield (18.26 t ha^{-1}) was obtained from farmers' practice.

Development of fertilizer recommendation for four crop based mustard-mungbean-T.aus-T.aman cropping pattern in high barind tract

Four crop based cropping pattern is highly productive but very nutrient exhaustive. This cropping pattern can hamper soil fertility if nutrient management is not judiciary use. For sustainable crop productivity a study was undertaken at Farming System Research and Development (FSRD) site, Kadamshahor, Godagari, Rajshahi during 2015-16 to find out an optimum and economic fertilizer dose for Mustard-Mungbean-T.Aus-T.Aman cropping pattern in High Barind Tract. The soil of the experimental field was chemically analyzed and levels of the fertilizers were calculated on the basis of target yields as per Fertilizer Recommendation Guide' 2012. The soil was low fertile having pH-7.60 (nutral), OM-0.94 (very low), total N-0.06%, available P- 11.55 micro g/g soil (low), available S-8.45 micro g/g soil (low), B-0.16 micro g/g soil (low) and Zn-0.23 micro g/g soil (very low). The treatments were T_1: Soil test based (STB) fertilizer dose (FRG, 2012), T_2: IPNS with 5 t cow dung ha^{-1}

as of T_1, T_3: T_1 + 25% NPK, T_4: IPNS with 5 t cow dung ha^{-1} as of T_3, T_5: Farmers' practice. Cultural practices adopted for different crops are as follows

Parameters	Four crop based pattern			
	Mustard	Mungbean	T.aus	T.aman
Variety	BARI Sarisha-15	BARI Mung-6	BRRI dhan48	BRRI dhan57
Sowing/ transplanting	20 October, 2015	29 February, 2016	15-20 May, 2016	08-12 August, 2016
Spacing (Row×hill)	Broadcast	20 cm × 15 cm	20 cm × 15 cm	20 cm × 15 cm
Seedling age (days)	-	-	20-25	20-25
Fertilizer dose (kg ha^{-1})	T_1:$N_{86}P_{23}K_{38}S_{27}Zn_2B_{1.5}$ T_2:$N_{71}P_{15.5}K_{24}S_{27}Zn_2B_{1.5}$ +5t CD ha^{-1} T_3:$N_{108}P_{29}K_{48}S_{27}Zn_2B_{1.5}$ T_4:$N_{93}P_{21.5}K_{38}S_{27}Zn_2B_{1.5}$ + 5 t CD ha^{-1} T_5:$N_{71}P_{15}K_{25}S_{160}$	$N_{20}P_{15}K_{16}$ $N_{20}P_{15}K_{16}$ $N_{25}P_{19}K_{20}$ $N_{25}P_{19}K_{20}$ $N_0P_0K_0$	$N_{80}P_{15}K_{30}S_{12}Zn_2$ $N_{80}P_{15}K_{30}S_{12}Zn_2$ $N_{100}P_{18.75}K_{37.50}S_{12}Zn_2$ $N_{100}P_{18.75}K_{37.50}S_{12}Zn_2$ $N_{75}P_{12}K_{26}S_{10}$	$N_{80}P_{15}K_{30}S_{12}Zn_2$ $N_{80}P_{15}K_{30}S_{12}Zn_2$ $N_{100}P_{18.75}K_{37.50}S_{12}Zn_2$ $N_{100}P_{18.75}K_{37.50}S_{12}Zn_2$ $N_{75}P_{12}K_{26}S_{10}$
Harvesting time	21 January, 2016	8-10 May, 2016	05-10 August, 2016	1-5 November, 2016
TAT (days)	7	30	3	3
Field duration (days)	87	74	80	82

The yield components and yield of all crops performed better in T_4: 25% higher doses and IPNS approach, nevertheless it gave the highest values of system productivity (18.09 t ha^{-1}), production efficiency (55.32 kg $ha^{-1}day^{-1}$) and gross return (Tk. 307440 ha^{-1}). But, gross margin (Tk. 116123 ha^{-1}) and MBCR (1.91) was the highest in T_3. The IPNS including treatments showed more production cost. The STB+25% NPK treatments with or without IPNS basis treat $N_{80}P_{15}K_{30}S_{12}Zn_2$ ments improved N, P and K uptake by the crops in the sequence. The apparent balance (difference between inputs and outputs) for N and K at system level was negative with the K balance being the most negative. The P balance was positive in all treatments except farmer practice T_5.

Development of fertilizer packages for white grain maize in high barind tract

A field experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Godagai, Rajshahi during Rabi season 2016-17 to develop an optimum fertilizer dose and their application method for white maize cultivation in High Barind Tract. The experiment was laid out in randomized complete block design with three replications. There were five treatments namely T_1= STB fertilizer dose applied by 3 splits (1/3rd urea at basal+1/3rd urea at 8-leaf stage+1/3rd urea at 16-leaf stage) T_2= STB fertilizer dose applied by 2 splits (2/3rd urea at basal + 1/3rd urea at 16-leaf stage) T_3= STB fertilizer dose applied by 2 splits (half urea at basal+half urea at 16-leaf stage) T_4= 75% STB fertilizer dose applied by 2 splits (2/3rd urea at basal+1/3rd urea at 16-leaf stage) T_5=75 % STB fertilizer dose applied by 2 splits (half urea at basal+half urea at 16-leaf stage. The T1 was remained without water stress while other treatments received only one irrigation at 16-leaf stage. The STB fertilizer dose was $N_{300}P_{75}K_{96}S_{34}Zn_5B_{1.5}$ kg ha^{-1}.The maximum plant height, ear height, grains cob^{-1}, cob length, grains weight cob^{-1}, hundred grains weight and grain yield were found in T_1 treatment STB fertilizer dose applied by 3 splits (1/3rd urea at basal+1/3rd urea at 8-leaf stage+1/3rd urea at 16-leaf stage). The T2 which received STB fertilizer and urea splitted twice (2/3rd urea at basal + 1/3rd urea at 16-leaf stage) showed second highest grain yield. The yield reduction was only 5% in T_2 over T_1. These are the first year result, for confirmation the trial should be repeated in the next year.

Development of fertilizer recommendation for potato-maize-T.Aman rice cropping pattern in high Ganges river floodplain

The experiment was carried out at farmer's field under MLT site, Shibpur, Puthia, Rajshahi during 2014-15 to 2015-16 to verify the present fertilizer recommendation for Potato-Maize-T. Aman rice cropping pattern. Four treatments viz. T_1= 100% recommended fertilizer dose based on STB and HYG basis); T_2= 25% increased than T_1; T_3= 50% increased than T_1 and T_4 = Farmers' Practice (Based on surveyed) were considered for the experiment to reach the objective. Management practices followed in Wheat-Mungbean-T. Aman rice cropping pattern

Management factors	Potato (BARI Alu-7)	Maize (BHM-9)	T. *Aman* rice (BRRI dhan33)
Date of sowing/ Transplanting	27-28/11/2015	10-12/3/2015	22-26/7/2015
Seedling age (days)	-	-	25
Unit plot size	5m × 4m	5m × 4m	5m × 4m
Spacing	60 cm × 20 cm	60 cm × 20 cm	20 cm × 15 cm
Fertilizer dose (kg ha^{-1})	T_1:$N_{148}P_{25}K_{106}S_{22}Zn_0B_2$ T_2:$N_{185}P_{32}K_{132}S_{27}Zn_0B_2$ T_3:$N_{222}P_{38}K_{158}S_{32}Zn_0B_2$ T_4:$N_{240}P_{72}K_{143}S_{20}Zn_4B_2$	T_1:$N_{254}P_{30}K_{50}S_{30}Zn_0B_0$ T_2:$N_{318}P_{37}K_{63}S_{38}Zn_0B_0$ T_3:$N_{381}P_{45}K_{75}S_{45}Zn_0B_0$ T_4:$N_{110}P_{16}K_{20}S_0Zn_0B_0$	T_1:$N_{66}P_9K_{20}S_{10}Zn_1B_0$ T_2:$N_{83}P_{11}K_{25}S_{13}Zn_1B_0$ T_3:$N_{99}P_{13}K_{30}S_{15}Zn_1B_0$ T_4:$N_{105}P_{30}K_{50}S_7Zn_3B_0$
Basal: N-P-K-S-Zn-B kg ha^{-1}	50-25-106-22-0-2	170-30-50-30-0-0	0-9-20-10-1-0
N top dress (DAT/DAS)	25 and 45 DAS,	35 DAS	15, 40 and 55 DAT
Pest control	Curative	Curative	Curative
Irrigation (DAS/DAT)	30 and 55	35, 60 and 90	-

System productivity in terms of REY was estimated for each treatment. Maximum REY (28.30 t ha^{-1}) was estimated in T_3 which was very close to that of T_2 and minimum in T_1 treatment. About 12% and 16% more REY in T_2 and T_3 respectively was obtained over T_1 treatment. Net return in T_3 was found as little bit higher than that of T_2. Despite of having higher gross return in T_3 but 50% higher dose of fertilizer put an extra cost to the farmers. For these consequences, higher BCR was recorded from T_2 as compared to T_3 and the lower from T_1 treatment after three years experimentation.

Response of muskmelon to chemical fertilizers at charlands in Faridpur

A study was conducted during the Kharif-I, 2016 at the farmer's field of Sadarpur upazila, Faridpur to find out an optimum and economically viable chemical fertilizer dose for maximum yield of muskmelon. The experiment was set up in Randomized Complete Block Design with four dispersed replications. Six treatments were considered in the study such as: T_1= HRC recommended dose of chemical fertilizers ($N_{60}P_{20}K_{30}S_{15}Zn_1B_1$ kg ha^{-1}), T_2= $N_{75}P_{25}K_{38}S_{20}Zn_{1.25}B_{1.25}$ kg ha^{-1} (T_1+25% of T_1), T_3= $N_{90}P_{30}K_{45}S_{23}Zn_{1.5}B_{1.5}$ kg ha^{-1} (T_1+50% of T_1), T_4= $N_{45}P_{15}K_{23}S_{11}Zn_{0.75}$ $B_{0.75}$Kg ha^{-1} (75% of T_1), T_5= $N_{100}P_{40}K_{28}S_{17}Zn_{3.5}B_{1.7}$ kg ha^{-1} (Farmer's practice), T_6= Native nutrient (control). Local variety of muskmelon was used. The unit plot size was 5 m × 5 m. Seeds were sown in pit on 18 to 20 April 2016 maintaining a spacing of 2.5 m from pit to pit. The highest fruit yield (22.22 t ha^{-1}) was recorded from T_2 might be due to producing maximum number of fruits plant^{-1}. The lowest fruit yield (11.12 t ha^{-1}) was obtained from control plot for performing the lowest in all yield contributing parameters. The highest gross return of Tk. 68143 ha^{-1} was found from T_2 (T_1+25% of T_1) due to the highest yield and the lowest gross return Tk. 34551 ha^{-1} was obtained from the absolute control treatment (T_6). The maximum benefit cost and ratio (1.64) was also recorded in T_2 and the lowest in absolute control treatment.

Nutrient management for Sunflower in coastal soil

A field experiment was conducted at MLT site, Amtali, Barguna during Rabi season of 2016-17 to evaluate the effect of nutrient management sunflower production in coastal region. Five treatment viz. T_1: Soil test based inorganic fertilizer dose for high yield, T_2: Fertilizer dose as per FRG' 2012, T_3:T_1 + 20% of T_1, T_4: T_2+ 20% of T_2 and T_5= Farmers practice were tested in the trial. The unit plot size was 8m×5m and BARI Sunflower-2 was used as the test crop in this experiment. The seeds were sown @ 16 kg ha^{-1} on16 December 2016 in line with the spacing of 50 cm × 25 cm. The crop was harvested on 06 April, 2017. Among the treatment combination it was observed that application of 200-60-95-40 kg, N-P-K-S ha^{-1} (T_3) performed the best over other treatments and it produced the highest seed yield (2.30 t ha^{-1}).

Effect of fertilizer management on quality seed production of soybean (Glycine max L.) in charland of Noakhali

A field experiment was conducted at Char Martin, multi location testing site, Laxmipur during late Kharif- II season of 2016 to find out the suitable fertilizer dose for quality seed production and to increase the availability of quality seed for upcoming Rabi season. Five treatment combinations viz. T_1= Native control, T_2= STB (17-27-55-2.7-2 kg, N-P-K-S-Zn ha^{-1}, T_3= 100% recommended dose (30-25-50-2.7 kg, N-P-K-S ha^{-1} FRG' 2012), T_4= 50% recommended dose+1.2 kg biofertilizer ha^{-1} and T_5= Farmers' practice (25-15 kg, N-P ha^{-1}) were tested. The experiment was laid out in randomized complete block design with 3 replications. Significant difference was observed among the treatment combinations in terms of yield and yield contributing characters. Application of 50% of the recommended doses of urea, TSP, MoP and biofertilizer (BARI RGm-901) at the rate of 1.2 kg ha-1 significantly increased most of the parameters such as the highest plant height, number of nodule per plant, pods per plant and seeds per pod. The highest seed yield (2.45 t ha-1) was recorded from plants treated with T4 while the lowest seed yield (1.46 t ha-1) was obtained from T1. The highest gross return (Tk. 269500 ha-1) and gross margin (Tk. 213716 ha-1) were obtained from T4 whereas the lowest gross return (Tk. 160600 ha^{-1}) and gross margin (Tk. 107600 ha^{-1}) was obtained from T_1. Overall results indicated that the application of biofertilizer (BARI RGm-901) with 50% N-P-K of the recommended dose would produce higher seed yield.

Project II: Improvement of Cropping System

Development of four crop based cropping patterns against farmers existing pattern in different agro-ecological zones of Bangladesh

The present experiment was conducted at 14 different FSRD and MLT sites of the country under On-Farm Research Division during 2015-16 and 2016-17 to increase cropping intensity and productivity through rice based cropping system, to sustain food security, poverty eradication and livelihood improvement of ever increasing population and to increase farmer's income, access to food and nutrition, employment generation and woman's participation in agriculture. A total of 7 different alternative cropping patterns with their existing patterns were tested. The cropping patterns tested with their location are given below:

List of alternative cropping patterns tested in different locations

Sl.#	Alternative cropping pattern	Farmers existing pattern	Location
1.	Mustard-Boro-T.*Aus*-T.*Aman*	Boro-T.*Aman* Mustard-Boro-T.*Aman*	Mymensingh, Dinajpur Rangpur, Khulna, Sherpur Pabna, Comilla, Bogra (8)
2.	Potato-Boro-T.*Aus*-T.*Aman*	Boro-T.*Aman* Potato-Boro-T.*Aman*	Dinajpur, Tangail , Rangpur, Comilla (4)

Sl.#	Alternative cropping pattern	Farmers existing pattern	Location
3.	Mustard-Mungbean-T.*Aus*-T.*Aman*	Boro-T.*Aman*	Kushtia and Bhola (2)
4.	Lentil-Mungbean-T.*Aus*-T.*Aman*	Lentil-Sesame-T.*Aman* Mustard-Boro-T.*Aman*	Faridpur and Barind (2)
5.	Mustard-Onion-T.*Aus*-T.*Aman*	Mustard-Boro-T.*Aman*	Faridpur (1)
6.	Mustard-Boro-Jute-T.*Aman*	Mustard-Boro-T.*Aman*	Tangail (1)
7.	Potato-Mungbean-T.*Aus*-T.*Aman*	Potato-Jute-T.*Aman* Rice	Rajshahi (1)

The result revealed that the alternate four crop cropping patterns could be established successfully with short duration varieties. Alternate cropping patterns was agronomically and economically more profitable than the existing patterns. Rice equivalent yield, productivity and profitability was higher than the farmers' existing cropping patterns. Rice equivalent yield of the farmers existing pattern varies from 8.50 to 34.52 whereas in the alternate improved cropping patterns it ranges from 16.05 to 43.46. Inclusion of new crops in the existing cropping pattern and replacing old and traditional varieties by modern improved varieties enhanced productivity and profitability.

The productivity and economic return of the improved four crop based patterns was higher as compared to farmer traditional patterns suggesting that improved pattern is more profitable than farmers pattern. The turn around time can be minimized about 134-140 days by practicing four crop production in a year. So, total crop production and cropping intensity can be increased with four crop based cropping pattern. The higher rice equivalent yield, gross return and gross margin was found in the alternate cropping patterns compared to existing patterns due to additional yield of included crops with new variety. So, crop cultivation in alternate cropping pattern would help to increase total production, farmer's income and employment opportunity.

Four crops based cropping pattern Mustard (BARI Sarisha-14)-Boro (BRRI dhan28)-T.*Aus* (BRRI dhan48)-T.*Aman* (BRRI dhan62) is agronomically feasible and economically profitable compared to the existing farmers cropping pattern Boro-T.*Aman* or Mustard-Boro -T.*Aman*. On an average, 335-345 days required to complete one cycle of alternate cropping pattern. Lentil and mungbean are included in the pattern which can meet up vegetable protein of farm families. Pulse crops produce nodule in their root system which contribute to enrich soil fertility. Lentil-Mumgbean-T.*Aus*-T.*Aman* is a promising cropping pattern for higher productivity and profitability. The replacement of boro rice and incorporation of short duration *Aus* rice in improved pattern reflects environment friendly and more productive practice. It can also increase soil health by inclusion of mungbean. Improved cropping pattern Mustard (BARI Sarisha-14) - Boro (BRRI dhan28) - Jute (0-9897) - T.*Aman* (BRRI dhan57) is also a profitable technology for Tangail region. Potato-Mungbean -T.*Aus*-T.*Aman* could be a suitable cropping pattern in Rajshahi region with higher return. It can be concluded that cultivation of alternate cropping patterns is profitable than that of existing patterns. So, cultivation of alternate cropping patterns would help to increase total production, farmer's income, improve soil health and reduce nutritional imbalance of human being.

Cropping intensity and productivity increased by adapting short duration varieties of rice specially T.*Aus* (BRRI dhan48), T.*Aman* (BRRI dhan62, BRRI dhan57, Binadhan-7), mustard (BARI Sarisha-14), potato (BARI Alu-7), mungbean (BARI Mung-6) and lentil (BARI Masur-7) in the existing cropping system. Cultivation of 4-crop in a year increased crop productivity but it is difficult to establish T.*Aus* rice due to labour crisis and sometimes for lacking of irrigation. Mechanized planting and harvesting can solve the problem. Sometimes market price of rice is low to compensate the production cost, especially high labour and irrigation cost. If rice price can be optimized four crop based cropping patterns will be more popularized.

Development of four crop based Garden pea -*Boro*-T.*Aus*-T.*Aman* cropping pattern against Garden pea-*Boro*-T.*Aman* cropping pattern

A field trial was conducted at the farmers' field of Bheramara MLT Site, Kushtia in 2015-16 to develop Garden pea (BARI Motorshooti-3)-*Boro* (BRRI dhan28)-T.*Aus* (BRRI dhan48)-T.*Aman* rice (BRRI dhan39) against Garden pea (BARI Motorshooti-3)- *Boro* (BRRI dhan28) - T.*Aman* rice (BRRI dhan39) cropping pattern. Higher Rice Equivalent yield (18.83%) and gross margin (10.84%) were obtained from alternate cropping pattern over existing cropping pattern in the year due to inclusion of new crops.

Development of four crops based Wheat-Mungbean-T.*Aus*-T.*Aman* cropping pattern against Lentil-Sesame-T.*Aman* cropping pattern

A field trial was conducted at the farmers' field of Kushtia MLT Site, Kushtia during 2015-16 and 2016-17 to develop Wheat-Mungbean-T.*Aus*-T.*Aman* rice cropping pattern against Lentil-Sesame-T.*Aman* rice cropping pattern. There were two treatments i.e, T_1: Existing Cropping pattern: Lentil (BARI Masur-6)-Sesame (BARI Til-3)-T.*Aman* (Binadhan-7) and T_2: Alternative Cropping pattern: Wheat (BARI Gom-28/BARI Gom-30)-Mungbean (BARI Mung-6)-T.*Aus* (BRRI dhan-48)-T.*Aman* (Binadhan-7). Higher REY (40.23%) was obtained in alternate cropping pattern due to introduction of new crops and varieties. Production efficiency of alternate cropping pattern and existing cropping pattern was found to be 40.18 and 23.25 kg/ha/day; respectively.Higher gross return (Tk. 290100 ha^{-1}) and gross margin (Tk. 107675 ha^{-1}) were obtained in improved pattern.

Improvement of Wheat–D.*Aus*/T.*Aus*–T.*Aman* cropping pattern through intervention of short duration T.*Aman* variety

The experiment was conducted at the farmers' field during 2014-15 to 2016-17 at Sadar, Bhola under AEZ-18 to observe the performance of improved cropping pattern against existing cropping pattern. There were two treatments viz., T_1= existing cropping pattern: wheat (BARI Gom-26)-D.*Aus*/T.*Aus* (Local -China irri))-T.*Aman* (BRRI dhan52) and T_2= improved cropping pattern: wheat (BARI Gom-26)-D.*Aus*/T.*Aus* (BRRI dhan48)-T.*Aman* (BRRI dhan33).The improved cropping pattern gave 15.85% higher rice equivalent yield (13.30 t ha^{-1}) than that of the existing pattern (1148 t ha^{-1}). In improved pattern, gross margin (Tk. 120520 ha^{-1}) were higher over existing pattern. Marginal benefit cost of improved pattern was 3.37 over existing pattern. Replacing of old and traditional varieties by modern improved varieties in the existing cropping pattern enhanced productivity and profitability.

Development of alternate cropping pattern Mustard-T.*Aus*-T.*Aman* rice against Fallow-T.*Aus*-T.*Aman* rice cropping pattern in aez 20

An experiment was executed at multilocation testing (MLT) site, Moulvibazar in 2016-17 to evaluate the performance of improved cropping pattern and to increase the productivity and income of the farmers. The existing and improved cropping patterns were Fallow-T.*Aus*-T.*Aman* rice (CP_1) and Mustard-T.*Aus*-T.*Aman* rice (CP_2), respectively. BRRI dhan65 and BRRI dhan57 were the improved varieties of *Aus* rice and T.*Aman* rice in the improved pattern. The improved pattern CP_2 provided 10.68 t ha^{-1} of T.*Aman* rice equivalent yield which was almost 69.52% higher than that of existing pattern $CP_{1.}$

Development of alternate copping pattern Garden Pea-Boro-T.*Aman* rice against Fallow-Boro-T.*Aman* Rice

The experiment was executed at MLT site, Dhirashram, Gazipur during 2015-16 to study the feasibility of growing garden pea as vegetable crop in the Fallow-Boro rice -T.*Aman* rice cropping pattern and to increase cropping intensity and farmers' income by using fallow land before boro cultivation. The existing and alternate cropping patterns were Fallow-Boro- T.*Aman* and Garden pea-Boro-T.*Aman* rice, respectively. Rice equivalent yield (REY) 17.95 t ha^{-1} was calculated from improved cropping pattern which was far better than the existing pattern (8.10 t ha^{-1}). REY increased 120% in improved pattern over the existing pattern. Maximum gross margin (Tk. 229846 ha^{-1}) was also in the improved cropping pattern. Inclusion of garden pea increased production efficiency and gave higher gross margin than existing pattern.The calculated MBCR was 7.66 indicating that alternate cropping pattern will produce more returns than the existing farmers' pattern.

Development of alternate cropping pattern Potato- Foxtail millet (HYV)- B.*Aman* against Potato -Foxtail millet (local variety)- B. *Aman* in the charland of munshiganj

The experiment was conducted in the farmers' field at MLT site, Munshiganj during 2015-16 and 2016-17 cropping season to test the agro-economic performance of alternate cropping pattern Potato-Foxtail millet (HYV)-B.*Aman* rice for increasing the cropping intensity and productivity. The predominant cropping pattern in the area is Potato-Foxtail millet (Local variety)–B.*Aman*. The mean yield of potato in last two years under alternate cropping pattern and farmers existing cropping pattern were 32.15 and 32.78 t ha^{-1} and mean yield of foxtail millet were 2.88 and 2.54 t ha^{-1}, respectively. Higher gross margin from potato (Tk.67049.00 ha^{-1}), BARI Kaon-2 (Tk.18400.00 ha^{-1}) were obtained from alternate cropping pattern than that of farmers existing cropping pattern (Tk.53191.00 ha^{-1}) and (Tk.10950.00 ha^{-1}), respectively. Considering the whole pattern, gross margin from alternate pattern was about 21% higher than farmers existing pattern.

Development of alternate cropping pattern Mustard- Boro- T. *Aman* rice against Fallow - Boro- T. *Aman* rice

A trial was conducted at OFRD, BARI, Pirgonj (Rajbari), Thakurgaon, Kishoregonj, Shibpur (Narsingdi), Debhata (Satkhira), Bhola and Netrokona (Mymensingh) during 2015-16 to improve the existing cropping pattern by inclusion of mustard and to increase crop yield and farmers' income. The alternate cropping pattern was Mustard-Boro rice-T. *Aman* rice against the existing Fallow-Boro rice-T. *Aman* rice pattern. The inclusion of mustard in between two rices increased the rice equivalent yield (REY) by 80-91% with farmers' existing pattern. The gross return was increased by 83-89% in Mustard-Boro-T.*Aman* rice sequences compared to existing rice-rice cropping pattern. The marginal benefit cost ratio, land utilization index and production efficiency indicated the superiority of the improved pattern over the farmers' practices. The experimental evidence reveals that there is an ample of substantial improvement of the productivity of double rice cropping sequence with the inclusion of high yielding mustard varieties.

Conservation agricultural practices in Wheat-Mungbean-T.*Aman* rice cropping pattern

A field experiment was conducted at Shibpur, Puthia, Rajshahi during rabi season of 2015-16 and 2016-17 to examine the performance of BARI developed tillage machinery and the effect of tillage options implanted by those machineries on wheat in wheat-mungbean-T.*Aman* rice under conservation agriculture systems in High Ganges River Floodplain soil. Seeds of BARI Gom-26 were sown under five tillage options i.e. strip tillage method, PTOS method, zero tillage method, bed planting method and conventional tillage method. The unit plot size was 6mx5m. Seeding was done with the help of BARI developed different tillage machinery. Seed of BARI Gom 26 @ 120 kg ha^{-1} was sown on 3rd week November. Crop was harvested on 3rd week of March. Among the tillage options, PTOS tillage method performed better in respect of yield and economic return. However, in case of wheat, the highest yield (3.97 t ha^{-1}) was obtained from bed planting method and the lowest (3.68 t ha^{-1}) was in zero tillage method. In case of mungbean, the highest yield (1.61 t ha^{-1}) was obtained from bed planting and the lowest (1.19 t ha^{-1}) from zero tillage method. In case of T.*Aman* rice, the maximum grain yield (4.95 t ha^{-1}) and straw yield (6.10 t ha^{-1}) was obtained from the conventional tillage system and the lowest from PTOS method. All the tillage machinery exhibited better performance in wheat and mungbean yield than conventional practice. Moreover, all tillage machineries contributed to higher economic return by reducing cultivation cost over the conventional tillage system and PTOS method provided the maximum gross margin (Tk. 123712 ha^{-1}) and BCR (1.90).

Development of alternate cropping pattern through T.*Aman* -Fallow-Wheat against T. *Aman* - Fallow-Fallow

The experiment was conducted at the MLT site, Koyra, Khulna during 2016-17 to improve the productivity and profitability of existing cropping pattern T. *Aman* -Fallow-Fallow by introducing heat and salinity tolerant, late potential wheat variety (BARI Gom-25). The improved cropping pattern T. *Aman* -Wheat –Fallow gave highest rice equivalent yield (REY) (7.10 t ha^{-1}) than farmers practice (5.05 t ha^{-1}). Including of wheat into existing T.*Aman*-Fallow -Fallow pattern gave highest gross return (Tk. 150906 ha^{-1}) and gross margin (Tk. 69506 ha^{-1}). Improved pattern gave MBCR of 2.08 meaning superiority of improved pattern over existing pattern.

Development of alternate cropping pattern T.*Aman*- Mustard-Indian Spinach against T.*Aman*- Mustard-Fallow

The experiment was conducted at the MLT site, Dumuria, Khulna under AEZ-13 during 2015-16 and 2016-17 to develop an improved cropping pattern against the farmers' existing one. The study was conducted using the improved cropping pattern (IP) T.*Aman*- Mustard-Indian spinach against the existing farmers cropping pattern (FP) T.*Aman*-Mustard-Fallow. Average over two years results shows that IP gave highest rice equivalent yield (REY) (29.45 t ha^{-1}) than FP (8.02 t ha^{-1}), which made the highest gross return (563281Tk. ha^{-1}) and gross margin (Tk. 418031 ha^{-1}). The MBCR of IP over FP was 4.84, which indicates replacement through IP is profitable.

Development of alternate cropping pattern through Garden Pea-Fallow-T.*Aman* against T.*Aman*-Fallow-Fallow

The experiment was conducted at the MLT site, Dumuria, Khulna under AEZ-13 of two subsequent years of 2015-16 and 2016-17 to improve the productivity and profitability of existing cropping pattern T. *Aman* -Fallow-Fallow by introducing new garden pea variety (BARI Motorshuti-3). Mean over two years data revealed that improved cropping pattern T. *Aman* -Garden pea-Fallow gave highest rice equivalent yield (REY) (17.73 t ha^{-1}) than farmers practice (5.34 t ha^{-1}). On the other hand improved cropping pattern T. *Aman* -Garden pea-Fallow gave highest gross return (Tk.339103 ha^{-1}) and gross margin (Tk. 249819 ha^{-1}). Improved pattern gave MBCR of 6.34 meaning superiority of improved pattern over existing pattern.

Performance of short duration mustard varieties in between b.*Aman* and boro rice

The experiment was conducted at MLT site Manikganj during the Rabi season of 2016-17 to verify the performance of short duration mustard varieties in between B. *Aman* and Boro rice. A total three short duration mustard varieties were tested in this experiment namely BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17. The unit plot size was 5 Deci. The seeds were sown on 9-12 November, 2016 after harvest of B.*Aman* rice. All the seed were sown as broadcast. BARI Sarisha-14 and 17 were harvested on 1 to 7 February, 2017, BARI Sarisha-15 on 7 to 10 February, 2017. The maximum days to maturity (87 days) was recorded in BARI Sarisha-15 & BARI Sarisha-17 and the minimum in BARI Sarisha -14 (85 days). The maximum no. of plants m^{-2} (69) was found in BARI Sarisha-15 and the minimum in BARI Sarisha 14 (63.83). Higher number of seeds $siliqua^{-1}$ was noted in BARI Sarisha-17 (31.50) which is statistically similar with BARI Sarisha-14 (28.83) and lowest in BARI Sarisha-15 (23.50). The maximum 1000-seed weight was found in BARI Sarisha-17 (3.40 g) followed by BARI Sarisha-15 (3.38 g) and lowest in BARI Sarisha-14 (3.35 g). Maximum seed yield (2.02 t ha^{-1}) was obtained from the variety BARI Sarisha-14 followed by BARI Sarisha-17 (2.01 t ha^{-1}) and lowest in BARI Sarisha-15 (1.91 t ha^{-1}).

Development of alternate cropping pattern Sunflower– Snake gourd -T. *Aman* rice against farmers existing pattern Sunflower --Fallow-T. *Aman* rice

The experiment was conducted at FSRD site, Razakhali during the year of 2016-2017 to determine the profitability of the alternate cropping pattern Sunflower (BARI Surjomukhi-2)- Snake gourd

(Hybrid Roshni)-T. *Aman* rice (BRRI dhan39) against the farmers' existing pattern Sunflower-Fallow-T. *Aman* rice (local: Moulata) under AEZ 13. The alternate cropping pattern found agronomically and economically more profitable than the existing pattern. The highest gross return (Tk. 935050 ha^{-1}), gross margin (Tk. 380550 ha^{-1}) and MBCR (1.62) were obtained from alternate cropping pattern over existing pattern.

Intercropping of onion for true seed production with sugarcane

A trial was carried out at the FSRD site, Hatgobindapur, Faridpur during the rabi 2016-17 to increase seed production avoiding lodging of onion plant by intercropped with sugarcane. Four treatments viz T_1: sole sugarcane, T_2: single line onion intercropped with sugarcane, T_3: double line onion intercropped with sugarcane and T_4: sole onion. The experiments were laid out in RCB design with five dispersed replications. BARI Piaz-1 was used as onion variety. The unit plot size was 100 m^2 (10mX10m). Sugarcane crop was fertilized with46-30-40-9-1-1 kg ha^{-1} N-P-K-S-Zn-B and that for onion was 120-65-80-25-3-1.5 kg ha^{-1}N-P-K-S-Zn-Bas per recommendation of FRG-2012.Sugarcane was planted during 16 November to 1 December 2016 with 80 cm spacing and that of onion 20 November to 1 December 2016. Irrigation was applied at 14-15, 40-56, 75-82 DAP. Onion was harvested as seed during 30 March to 9 April 2017. The highest seed yield (460 kg ha^{-1}) was obtained from sole onion treatment (T_1). In between intercropped treatment, T_3 (onion planted in double line) showed the higher seed yield (233.4 kg ha^{-1}) where as T_2 (onion planted in single line) treatment gave only 160.8 kg ha^{-1}. Seed yield was increased by 45.14% in T_3 over T_2. It might be due to the higher plant population m^{-2} (15.8) and lower lodging percentage of onion inflorescence (2.14%) that provides mechanical support to erect inT_3 treatment plants. In between intercropped treatment, T_3 showed the higher gross return (Tk. 291250ha^{-1}), gross margin (Tk.192425 ha^{-1}) and BCR (2.95)over T_2 treatment. The gross margin was increased by 48.6 % in T_3 over T_2 and total variable cost was lower 18% in T_3 over T_4.

Intercropping onion and garlic with chilli in bhola

A field trial was carried out at MLT site, Sadar, Bhola under AEZ-18 during Rabi 2015-16 and 2016-17 to evaluate the performance of intercropping onion with chilli and onion with groundnut for higher productivity and economic return. Due to intercropping onion and garlic with chilli yield of chilli did not varied significantly. The unit plot size was 8 m 5 m. Spacing of chilli was 40 cm 40 cm. Plant to plant distance of onion was 15 cm and garlic was 10 cm. Fertilizer rate was 82-47-34-22-1 kg ha^{-1} N-P-K-S-Zn, respectively and CD 5 t ha^{-1} for sole chilli. 35 to 40 days old seedlings of chilli (var. BARI morich 1) and onion (var. BARI Piaz1) were planted 10-15 December in 2015 and 15-20 December in 2016. Groundnut (var. Dhaka 1) seed and onion seedling were planted from 18-22 December 2016. Onion was harvested at 105-108 DAS. In 2015-16 ripen chilli was harvested two times and in 2016-17 it was harvested once due to early heavy rain in April. Intercropping onion did not affect chilli yield significantly. Moreover, it increased system productivity over sole chilli. Two rows of onion between two rows of chilli gave the highest dry chilli equivalent yield (2.55 t ha^{-1}). One row onion in between two rows of groundnut also produced significantly higher groundnut equivalent yield over sole groundnut. Considering yield, gross margin and MBCR, the rresults revealed that two rows of onion between two rows of chilli and one row onion in between two rows of groundnut might be suitable for higher productivity and economic return for Bhola region.

Intercropping of groundnut with garlic in charland

A field experiment was conducted at Debdhunga, Sariakandi, Bogra during 2016-17 under AEZ-4 to find out suitable intercropping practice groundnut with garlic and to increase total production by introducing intercrops for higher economic return. The experimental design was used RCB with three replications. There were four treatments viz. T1=Sole groundnut, T2= Groundnut (100%) + 2 rows garlic in between groundnut rows (garlic 75%), T3= 2 rows of garlic in alternate with one row of groundnut and T4= one row of garlic in alternate with one row of groundnut were considered. The unit plot size was 8m×5m. The variety of groundnut was BARI Chinabadam-8 and garlic was BARI Rasun-1. The sowing date of groundnut and garlic was 10-12 November, 2016. The plant spacing was 40 cm × 15 cm for groundnut and 15 cm × 5 cm for garlic. The garlic was harvested on 10 April, 2017 and groundnut harvested on 29 April, 2017. The highest groundnut equivalent yield (7.54 tha^{-1}) was obtained from the treatment with 2 rows of garlic in alternate with one row of groundnut (T_3) which was close to T_2 and T_4 treatment. But the lowest equivalent yield 2.48 tha^{-1} was obtained from sole groundnut (T_1). The highest gross return (Tk. 414700 ha^{-1}) and gross margin (Tk. 318761 ha^{-1}) were obtained from T_3 (2 rows of garlic in alternate with one row of groundnut) followed by T_2 (Tk. 344300 and 259611 ha^{-1}) and T_4 (Tk. 318450 and 245011 ha^{-1}), respectively. The lowest gross return (Tk. 136400 ha^{-1}) and gross margin (Tk. 67761ha^{-1}) was obtained from sole ground (T_1). Therefore, intercropping system is better than that of sole cropping system.

Intercropping of gardenpea with hybrid maize

The experiment was conducted at the farmers' field of Phulpur MLT site, under On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Mymensingh in rabi season during 2016-17 to evaluate the productivity and profitability of maize under intercropping systems with garden pea. The treatments were T_1=Sole maize, T_2=One row of garden pea in between two rows of maize and T_3= Two rows of garden pea in between two rows of maize. Treatments were arranged in a randomized complete block design with six dispersed replications. The crop varieties were used BARI Hybrid Bhutta-9 and BARI Motorshuti-3. The experiment was laid out in a randomized complete block design with six dispersed replications. The unit plot size was 8.0 m × 5.0 m. Maize was sown in 60 cm apart rows with 20 cm between the plants both in sole and intercrop situation in normal row of maize. Sowing of both the crops maize and garden pea was done on 12 November 2016. Garden pea was harvested on 15 January 2017 and maize on 05 April 2017.Between the intercropped treatments, two rows of garden pea in between two rows of maize showed higher harvest index (42.76), maize equivalent yield (17.45 t ha^{-1}), land equivalent ratio 1.50, gross return (Tk. 287820 ha^{-1}) and MBCR (2.07) as compared to other treatments.

Intercropping of maize with short duration vegetables and spices

A field experiment was conducted at MLT site, Moulvibazar during 2015-16. Eight intercrop combinations, T_1 = Maize + Potato, T_2 = Maize + Red amaranth, T_3 = Maize + Spinach, T_4 = Maize+ Data Shak, T_5 = Maize + French bean, T_6 = Maize+ Garden Pea T_7 = Maize+ Coriander and T_8 = Sole Maize (100% Maize) were consider. It was laid out in Randomized Complete Block Design (RCBD) with six dispersed (six farmer's field) replications. The unit plot size was 8 m × 5 m. Hybrid maize (BARI Hybrid Bhutta-9), potato (Daimant), spinach (Local), red amaranth (BARI Lalshak-1), french bean (BARI Jharsheem-3) and coriander (local) were used as component crops. The seeds of maize, potato, spinach, red amaranth, data shak, and coriander were sown during 10-12 December, 2015. Fertilizers were applied @ 255-55-1-40-40-6-2 kg ha^{-1} N-P-K-Zn-B for maize. The component crops were harvested 7-24 February,2016 and maize harvested from 25-30 May, 2016.The highest maize equivalent yield 12.88 t ha^{-1} was recorded from the treatment T_6 (100% maize + garden pea) that of the lowest yield (7.33 tha^{-1}) was obtained from the treatment T_8 (sole maize). The highest gross return (Tk. 244720 ha^{-1}) and gross margin (Tk. 141870 ha^{-1}) was obtained from the treatment T_6 (100% maize + garden pea) and the lowest gross return (Tk. 143070 ha^{-1}) and gross margin (Tk. 75450 ha^{-1}) was obtained from the treatment T_8 (sole maize).

Intercropping of coriander with garlic at charland ecosystem

A field experiment on intercropping of coriander with garlic was conducted at char land of Trishal in Mymensingh during rabi season of 2015-16 and 2016-17 to evaluate the performance of garlic production in intercropping system and to increase land use efficiency. Three treatments viz.$T_{1=}$ Sole garlic, $T_{2=}$garlic + coriander (1 time cultivation) and $T_{3=}$garlic + coriander (2 times cultivation) were considered. The experiment was laid out in randomized complete block design with three replications.

The unit plot size was 3 m × 5 m. Seeds of garlic (var. BARI Rasun-2) and coriander (var. BARI Dhania-1) were sown on 5 November 2016 and 7 November 2016, spacing for garlic was 10 cm x 10 cm. Fertilizers were applied in each plot at the rate of 5 t ha^{-1} cowdung and 100-53-167-20 kg ha^{-1} NPKS, respectively. First time sowing coriander was harvested at 40 days after sowing (DAS) and Second time sowing coriander was harvested 45 DAS. Garlic was harvested on15 February, 2016 (130 DAS) and 16 February, 2017 (131 DAS. Intercropping reduced garlic yield 8-17% but productivity increased by 7.8-19.4% due to additional yield of coriander leaf. The highest garlic equivalent yield (9.79 t ha^{-1}), gross return (Tk 6,85,300 ha^{-1}) and gross margin (Tk 5,12,700 ha^{-1}) were obtained from garlic+ Coriander (2 times cultivation). Therefore, garlic + Coriander (2 times cultivation) might be suitable combination for higher productivity and economic return.

Intercropping of leafy vegetables with sweet gourd at charland

A field experiment on intercropping of leafy vegetables with sweet gourd was conducted at char land of sadar upazilla under Mymensingh district during rabi season 2016-2017 to select a suitable leafy vegetable for higher productivity and maximum economic return. For this purpose, six crop combinations viz., sweet gourd + red amaranth, sweet gourd + coriander leaf, sweet gourd + radish leaf, sweet gourd + mustard leaf, sweet gourd + spinach and sole sweet gourd were investigated following randomized complete block design with 3 dispersed replications. The unit plot size was 4m × 4m. BARI Mistikumra-1, BARI Dhonia-1, BARI Lalshak-1, BARI Mula-4, BARI Sarisha-14 and local spinach varieties were used as intercrop in this experiment. The seeds of sweet gourd were directly sown on 3rd November, 2016 maintaining a spacing of 2m × 2m and seeds of leafy vegetables were broadcasted at the same date. Leaves of mustard, radish, red amaranth, coriander and spinach were harvested on 32, 35, 37, 42 and 45 days after sowing (DAS). First sweet gourd was harvested on 2nd January' 2017 and it was continued up to 27th February' 2017.Intercropping leafy vegetables reduced sweet gourd yield up to 34%, although, it increased total productivity (expressed as sweet gourd equivalent yield) by 24-56% over sole sweet gourd. All the intercropping combinations were performed better in terms of sweet gourd equivalent yield, gross return and benefit cost ratio (BCR) over sole crops. However, the highest sweet gourd equivalent yield (39.00 t ha^{-1}) and gross return (Tk 390000 ha^{-1}) were obtained from sweet gourd + red amaranth combination which revealed that sweet gourd + red amaranth might be suitable combination for higher productivity and economic return.

Intercropping of summer leafy vegetables with mukhikachu

A field experiment on intercropping of summer vegetables with mukhikacu was conducted at char land of Trishal in Mymensingh during rabi season of 2016-17 to evaluate the performance of mukhikachu production in intercropping system and to increase the land use efficiency. Three treatments viz. T_1 = Sole mukhikacu, T_2 = mukhikacu + datashak (two rows in line sowing) and T_3 = mukhikacu + patshak (broadcast) were considered. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 3 m ×4.5 m. Seeds of mukhikachu (var. BARI Mukhikachu-1), Datashak (var. BARI Danta-1) and Patshak (Local) were sown on 15 February 2016 and spacing for mukhikachu was 60cm x 45cm. Patshak and datashak were harvested at 45 and 60 days after sowing (DAS). Mukhikachu was harvested on 20 September, 2016. Intercropping reduced mukhikacu yield by 4-14% but productivity increased by 9.26-30.82% due to additional yield of vegetable leaf. The highest mukhikacu equivalent yield (33.57 t ha^{-1}), gross return (Tk 6,71,400 ha^{-1}) and gross margin (Tk 5,05,750 ha^{-1}) were obtained from mukhikacu + datashak. Therefore, mukhikacu + datashak (two rows in line sowing) might be suitable combination for higher productivity and economic return.

Intercropping of garlic with groundnut

A field experiment was conducted at Jharbari, Birgonj, Dinajpur during the rabi season of 2015-16 and 2016-17 under Agro-Ecological Zone 1 to improve the productivity of existing cropping pattern by introducing new crops and varieties for higher yield and economic return. Three treatment combinations viz. T_1= Sole groundnut (40 cm 15 cm), T_2= Groundnut + 1 row garlic (15cm 5cm) and T_3= Groundnut + 2 rows garlic (15cm 5cm) were considered. The unit plot size was 6 m 5 m. Groundnut (BARI Chnabanam-8) and garlic (BARI Rasun-2) were used as planting materials. The groundnut and garlic was sown on November 10-15. The garlic was harvested on 25-30 March and groundnut harvested on 15-20 April. The highest groundnut equivalent yield (4.94 t ha^{1}) was recorded from groundnut + 2 rows garlic and the lowest in sole groundnut. The highest gross return (Tk 345900 ha^{-1}) and gross margin (Tk 288675 ha^{-1}) were obtained from the treatment groundnut + 2 rows garlic and the lowest in sole groundnut.

Intercropping of blackgram with Banana

An experiment was carried out at Kaliganj MLT site, Jhenidah during 2016-17 to evaluate the performance of blackgram intercropping with banana. Four treatments viz. i) Sole banana (2m x 2m), ii) 3 rows of blackgram in between 2 rows of banana, iii) 4 rows of blackgram in between 2 rows of banana and iii) 5 rows of blackgram in between 2 rows of banana were used in the experiment. The experiment was laid out in RCB design with 6 replications. Banana was transplanted on 15 April, 2016 maintaining the spacing of 2m x 2m and blackgram was sown on 15 August 2016 in between two rows of banana as per treatments. Fertilizers were used @ 750-900-525-750-45 kg Urea, TSP, MoP, Gypsum and Zinc ha^{-1} respectively and cow dung 5 t ha. Blackgram was harvested on 5-10 November 2016 and banana was harvested from 10-20 March 2017. The highest blackgram yield (1.57 t ha^{-1}) was produced from T4 (5 rows of blackgram in between 2 rows of banana) followed by T3 (4 rows of blackgram in between 2 rows of banana) and this was lowest (1.27 t ha^{-1}) from T2 (3 rows of blackgram in between 2 rows of banana). The highest gross margin (Tk. 385200 ha^{-1}) was found from T4 (5 rows of blackgram in between 2 rows of banana). The lowest gross margin (Tk. 292200 ha^{-1}) was found from T1 (Sole banana).

Intercropping of gardenpea with Hybrid Maize

The experiment was conducted at MLT site Kaligonj, Jhenidah during 2015-16 and 2016-17 to find out the suitable intercrop combination of maize and garden pea for higher yield as well as increase productivity and economic return of the farmers. The experiment consisted of three treatments, viz., T_1= Sole hybrid maize, T_2= One row garden pea between two rows of maize, T_3= Two row garden pea between two rows of maize. The treatments were tested in randomized complete block design with 3 replications. The unit plot size was 3m x 4m. The tested variety was BARI hybrid Bhutta-9 and BARI motorshuti 3. Seeds of maize and motorshuti were sown on 30 November 2016. Motorshuti was harvested on 09 February and maize on 26 April 2017. The highest maize yield (9.43 t ha^{-1}) was produced from sole maize and this was lowest (8.11t ha^{-1}) from two row gardenpea intercropping between two rows of maize. The highest maize equivalent yield (18.74 t ha^{-1}) was produced by three rows garden pea between two rows of maize and the lowest (9.43 t ha^{-1}) from sole maize. The highest gross margin (Tk. 184420 ha^{-1}) was found from three row garden pea between two rows of maize intercropping system. The lowest gross margin (Tk. 55620 ha^{-1}) was found from sole maize.

Intercropping of mungbean with Banana

An experiment was carried out at Kaliganj MLT site, Jhenidah during 2016-17 to evaluate the performance of mungbean intercropping with banana. Four treatments viz. i) Sole banana (2m x 2m), ii) 3 rows of mungbean in between 2 rows of banana, iii) 4 rows of mungbean in between 2 rows of banana and iii) 5 rows of mungbean in between 2 rows of banana were used in the experiment. The experiment was laid out in RCB design with 6 replications. Locally available shonamug was intercropped with anajikola (kanchkola). The plot size of the experiment was 10m x 10m. Banana was transplanted on 15 April 2016 maintaining the spacing of 2m x 2m and mungbean was sown on 20 August 2016 in between two rows of banana as per treatments. Mungbean was harvested on 10 November 2016 and banana was harvested from 10-20 March 2017.The highest mungbean yield (1.53 t ha^{-1}) was produced from T_4 (5 rows of mungbean in between 2 rows of banana) followed by T_3 (4 rows of mungbean in between 2 rows of banana) and this was lowest (1.20 t ha^{-1}) from T_2 (3 rows of mungbean in between 2 rows of banana). The highest gross margin (Tk. 421950 ha^{-1}) was found from T_4 (5 rows of mungbean in between 2 rows of banana). The lowest gross margin (Tk. 322500 ha^{-1}) was found from T_1 (Sole banana).

Intercropping of red amaranth, coriander and radish with pointed gourd

A field experiment was conducted at the MLT site Modhupur, Tangail during 2014-15 & 2015-16 under AEZ-9 & 28 to improve the productivity of existing cropping pattern by intercropping and to increase yield and economic profitability of farmers. Four treatment combinations viz. T_1= Pointed gourd + red amaranth, T_2= Pointed gourd + coriander (leaf), T_3= Pointed gourd + jute (leaf) and T_4= Sole Pointed gourd were consider.The unit plot size was 50 m^2. Pointed gourd (BARI Patal-2), red amaranth (BARI Lalshak-1), coriander leaf (local), jute leaf (local) were used as the experimental materials. The highest pointed gourd equivalent yield 32.86 t ha^{-1} was recorded from the treatment T_2 (Pointed gourd + coriander leaf) and that of the lowest yield (24.79 t ha^{-1}) was obtained from the treatment T_4 (sole pointed gourd). The highest gross return (Tk. 558615 ha^{-1}) and gross margin (Tk. 338940 ha^{-1}) was obtained from the treatment T_2 (Pointed gourd + coriander leaf) and the lowest gross return (Tk. 421345 ha^{-1}) and gross margin (Tk. 205862 ha^{-1}) was obtained from the treatment T_1 (sole pointed gourd).

Performance of intercrop vegetables, pulses and spices crops with sugarcane at char land of Jamalpur

An experiment was carried out to find suitable intercrop with sugarcane at char land of Jamalpur during November, 2015 to December, 2016. ISD-39 sugarcane variety was used in the study. Ten treatments were included in the study these were, T_1= Sugarcane+lentil, T_2= Sugarcane+gardenpea, T_3= Sugarcane+coriander, T_4= Sugarcane+potato, T_5= Sugarcane+onion, T_6= Sugarcane+garlic, T_7= Sugarcane+lalsak+mungbean, T_8= Sugarcane+spinach, T_9= Sugarcane+radish, T_{10}= Sole sugarcane. The treatments were tested in randomized complete block design with 3 dispersed replications. The unit plot size was 4 m × 3.6 m and spacing for sugarcane was 120 cm × 60 cm double row system. ISD-39 for sugarcane and BARI variety were used for vegetable, pulses and spices crops. Vegetable, pulses and spices crops were sown in lines between the sugarcane rows maintaining the spacing of the respective vegetables, pulses and spices crops. The sugarcane sets planted on 25 December, 2015 and vegetables, pulses and spices were sown on 07 December, 2015. Sugarcane was harvested on 25 December, 2016 and vegetables, pulses, spices were harvested according to their maturity. The result indicated that sugarcane yield was reduced due to intercropping systems. The highest yield of sugarcane was found from sole sugarcane (153.54 t ha^{-1}) and lowest yield (142.91 t ha^{-1}) was found when it was grown with radish. The highest sugarcane equivalent yield (170.28 t ha^{-1}) was obtained from sugarcane+potato intercropping systems which gave 10.90% higher yield over sole sugarcane. The highest gross return (468270 Tk. ha^{-1}) was found when it was grown with potato and the highest gross margin (267501 Tk. ha^{-1}) was found when it was grown with lentil.

Performance of intercropping groundnut with sesame

The experiment was carried out at the farmers' field of Mymensingh sadar, under On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Mymensingh to find out the suitable intercropping system in increasing crop productivity and profitability during 2016. The treatments were T_1 = sole groundnut, T_2 = sole sesame, T_3 = Two rows of groundnut in between two paired rows of sesame, T_4= Three rows of groundnut in between two paired rows of sesame. Treatments were arranged in a randomized complete block design with six dispersed replications. The unit plot size was 8.0 m × 5.0 m. Sesame was sown in paired 30 cm apart rows and 75 cm between two pairs with 5 cm between the plants. The spacing maintained for sole groundnut was 25 cm×10 cm. Sowing was done on 13 March 2016 for both crops. Sesame was harvested on 12 June 2016 and groundnut was also harvested on 21 July 2016. Between the intercropped treatments, three rows of groundnut in between two paired rows of sesame showed higher sesame equivalent yield (2.62 t ha^{-1}) and land equivalent ratio 1.55 as compared to other treatments.

Validation of intercropping lentil with brinjal at varying planting geometry

The experiment was conducted at Multi-location Testing Site Shimakhali, Magura during 2015-16 and 2016-17 to find out the performance of brinjal and lentil for higher yield as well as increase productivity and economic return of the farmers. Three treatments viz. T_1= Sole Brinjal (75 cm × 60 cm), T_2= Brinjal (100%) + Two line lentil in between brinjal, T_3= Brinjal (100%) + Three line lentil in between brinjal. The experiment was laid out in RCB with three replications using the variety of BARI Masur-6. Lentil was sown on 10 November 2016. The fertilizer doze for the first treatment was 160-48-120-20-3-0.9 kg ha^{-1} NPKSZnB for brinjal and 28-18-20-4-1 kg ha^{-1} NPKSB for lentil. The plants were harvested on 5 March 2017. The highest brinjal yield (19.43 t ha^{-1}) was produced from sole brinjal and this was lowest (15.03 t ha^{-1}) from three line lentil in between brinjal. The highest brinjal equivalent yield (24.42 t ha^{-1}) was produced by two line lentil in between brinjal and the lowest (19.43 t ha^{-1}) from sole brinjal. The highest gross margin (Tk. 338200 ha^{-1}) and benefit cost ratio (3.25) was found from two line lentil in between brinjal intercropping system. The lowest gross margin (Tk. 241600 ha^{-1}) and benefit cost ratio (2.64) was found from sole brinjal.

Study on intercropping of vegetables with hybrid maize

The experiment was conducted at MLT site, Manikganj during Rabi season of 2016-17 to study the feasibility of intercropping of vegetables with hybrid maize and economic returns. There were four crop combinations viz.$T_{1:}$ Sole Maize (var. BARI Hybrid Bhutta-9), T_2: Maize + Red amaranth (var. BARI Lalshak-1) and T_3: Maize + Radish (var. BARI Mula-4) T_4: Maize + Indian spinach (BARI Puishak-1) were used. The crop combinations were arranged in Randomized Complete Block Design with six replications. The unit plot size was 8m 5m. Seed of red amaranth, radish, indian spinach were broadcast between two (75cm apart) rows of maize. The spacing of sole maize was 75 cm 25 cm. The crop was fertilized with 250-60-100-30-5-1 kg, N-P-K-S-Zn-B ha^{-1} respectively. BARI Hybrid Bhutta-9 was sown on 25 October to 12 November, 2017. Vegetable seeds were sown on 24 November to 7 December, 2017. The intercrops of red amaranth, radish and spinach were harvested during 35-40 DAS. The maize crop was harvested on 22- 23 May, 2017. Maize equivalent yields ranged from 8.58-15.75 t ha^{-1}. The highest maize equivalent yield (15.75 t ha^{-1}), gross return (Tk. 250927 ha^{-1}) and gross margin (Tk. 122911 ha^{-1}) were obtained from maize + red amaranth combination. The lowest maize equivalent yield (8.58 t ha^{-1}), gross return (Tk. 142930 ha^{-1}) and gross margin (Tk. 115016 ha^{-1}) were obtained from sole maize cropping.

Performance of intercropping of garden pea varieties with maize in the coastal area of Khulna

The experiment was conducted at the MLT site, Dumuria, Khulna during rabi season, 2014-15, 2015-16 and 2016-17 to find out the performance of garden pea varieties as intercrops with hybrid maize. Four treatment combinations were investigated as T_1: Sole maize (75cm x 25cm), T_2: Two rows of BARI Motorshuti-1 (30 cm apart) in between two rows of maize, T_3: Two rows of BARI Motorshuti-3 (30cm apart) in between two rows of maize, T_4: Two rows of local garden pea (30 cm apart) in between two rows of maize. The experiment was laid out in RCB design with three replications. The unit plot size was 3.0×2.5m. The experimental plot was fertilized with 250-120-120-40-5-1 kg ha^{-1} of N-P-K-S-Zn-B, respectively. Seeds of maize and garden pea were sown on November 16, 2014 and 20 November 2015 and 18 November 2016. Garden pea was harvested from January 20- February 5, 2015 and 1-15 February, 2016 and January 27 to 16 February, 2017. Maize was harvested on April 21, 2015, 27 April 2016 and 25 April 2017. The highest maize grain yield (8.77 t ha^{-1}) was recorded from $T_{1,}$ sole maize cropping and the highest maize equivalent yield (15.80 t ha^{-1}) was obtained from T_3 when BARI Motorshuti-3 was intercropped with maize, which gave highest gross return (Tk. 237000 ha^{-1}) and gross margin (Tk. 171,825 ha^{-1}).

Validation of intercropping lentil with brinjal at varying planting geometry

The experiment was conducted at Multi-location Testing Site Shimakhali, Magura during 2015-16 and 2016-17 to find out the performance of brinjal and lentil for higher yield as well as increase productivity and economic return of the farmers. Three treatments viz. T_1= Sole Brinjal (75 cm × 60 cm), T_2= Brinjal (100%) + Two line lentil in between brinjal, T_3= Brinjal (100%) + Three line lentil in between brinjal. The experiment was laid out in RCB design with three replications using the variety of BARI Masur-6.The highest brinjal yield (19.43 t ha^{-1}) was produced from sole brinjal and this was lowest (15.03 t ha^{-1}) from three line lentil in between brinjal. The highest brinjal equivalent yield (24.42 t ha^{-1}) was produced by two line lentil in between brinjal and the lowest (19.43 t ha^{-1}) from sole brinjal. The highest gross margin (Tk. 338200 ha^{-1}) and benefit cost ratio (3.25) was found from two line lentil in between brinjal intercropping system. The lowest gross margin (Tk. 241600 ha^{-1}) and benefit cost ratio (2.64) was found from sole brinjal.

Intercropping of different winter vegetables with maize

The experiment was carried out at the farmer's field under MLT site, Raniganj, Sader, Dinajpur during rabi season of 2016-2017 to find out suitable crop combination for high crop productivity and economic return. Four different treatments were studied viz. T_1 = 100% maize with normal row (60cm20cm), T_2 = Maize paired row (100%) + 1 line potato, T_3 = Maize paired row (100%) + 1 line cabbage and T_4 = Maize paired row (100%) + 1 line cauliflower were evaluated. The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 6m 4m. Fertilizers were applied @ 260-72-148-48-4-2 kg ha^{-1} N-P-K-S-Zn-B, respectively. Maize (BARI hybrid Bhutta-9) and cabbage (BARI Badhacopy-1) were sown on 02 November 2016 and 12 November 2016, respectively. Potato, Cabbage and Cauliflower was harvested on January 10, 2017 and the maize on April 10, 2017. The highest maize equivalent yield (20.89 t ha^{-1}) was obtained in maize paired row (100%) + 1 line cauliflower followed by maize paired row (100%) + 1 line cabbage and the lowest was in 100% maize with normal row. The highest gross return(Tk. 313290 ha^{-1}), gross margin(Tk. 219060 ha^{-1}) and BCR (3.32) were obtained in maize paired row (100%) + 1 line cauliflower. The overall results indicated that among the intercrop combinations maize paired row + 1 line cauliflower and maize paired row (100%) + 1 line cabbage were found suitable for total productivity and economic return of the system.

Mixed cropping of linseed with groundnut varying plant population at charland ecosystem

The experiment was conducted in the farmers' field at the MLT site, Bhuapur, Tangail during Rabi 2016-17 under AEZ 8 to verify the performance of groundnut as mixed crop with linseed in char lands and to increase production and farmers' income. The treatment combinations used for the experiment were T_1: Sole groundnut (100%), T_2: Sole linseed, T_3: Groundnut (100%) + linseed (15%), T_4: Groundnut (100%) + linseed (30 %) and T_5: Groundnut (100%) + linseed (45%). Seeds of groundnut (BARI Chinabadam-8) were sown in line with 30 cm x 15 cm spacing and linseed (BARI Tish-1i) were broadcasted in groundnut plot. Both crop seeds were sown on 26 to 27 November, 2016. The plots were fertilized with 21, 36, 25, 10 and 0.4 kg ha^{-1} N, P, K, S and B, respectively. Linseed was harvested on 20 to 22 March, 2017 whereas groundnut on 5 to 6 May, 2017. The highest groundnut equivalent yield (1.39 t ha^{-1}) was found in the treatment combination of 100% groundnut + 45% linseed. From cost and return analysis it was observed that the combination of 100% groundnut + 45% linseed (T_5) gave the highest gross return (Tk.131533 ha^{-1}) and gross margin (Tk. 85173 ha^{-1}) where sole linseed (T_2) and sole groundnut (T_1) gave the lowest gross return (Tk 68600 and 102667 ha^{-1}) and gross margin (Tk.52150 and 61122 ha^{-1}), respectively.

Effect of planting method on mustard- boro mixed cropping system

A field experiment was carried out at Multi Location Testing (MLT) site, Debidwer and Chandpur during Rabi season of 2016-17 to find out the suitable rice planting method and to calculate the cost and return of mixed cropping system in Comilla region. The four treatment combinations used for the experiment were T_1 = Boro rice (broadcasting) + Mustard, T_2 = Boro rice (Line sowing) + Mustard, T_3 = Sole mustard, T_4 = Sole boro rice. The experiment was laid out in RCBD with five dispersed replications. Seeds of Mustard (BARI Sarisha-14) and Boro rice (BARI dhan29) were broadcasted and line sowed on 25-27 November 2016 @ 8 and 40 kg ha^{-1} respectively. The unit plot size was 100 m^2. The lands were fertilized with 18.43, 16, 20, 7, 1.43 and 1.36 kg N-P-K-S-Zn and B ha^{-1}, respectively. Mustard was harvested on 08-09 February 2017, whereas boro rice on 19-21 April, 2017. The highest rice equivalent yield (8.55 t ha^{-1}) was found in the treatment combination of boro rice line sowing + mustard (T_2). From the cost and return analysis it was observed that the combination of boro rice line sowing with mustard (T_2) gave the highest gross return (Tk.128250 ha^{-1}) and gross margin (Tk.53700 ha^{-1}) where sole crop of mustard (T_3) gave the lowest gross return (Tk.58050 ha^{-1}) and gross margin (Tk. 22310 ha^{-1}) which indicated the advantage of mixed cropping over the sole cropping.

Mixed cropping of field pea with mustard

The field experiment was carried out at South Lemua, MLT site, Feni (AEZ 19a) during Rabi season of 2016-17 to verify the performance of Field pea as mixed crop with Mustard. The treatment combinations used for the experiment were T_1 = Sole Field pea (100 %) @ seed rate 50 kg ha^{-1}, T_2 =Sole Mustard (100%) @ seed rate 10 kg ha^{-1}, T_3 = Field pea (90%) + Mustard (10 %), T_4 = Field pea (80 %) + Mustard (20 %) and T_5 = Field pea (70 %) + Mustard (30%). The experiment was laid out in Randomized Complete Block design with six dispersed replications. Seeds of Field pea (BARI Motor-1) and Mustard (BARI Sarisha-14) were broadcasted on 11 to 14 December, 2016. The unit plot size was 40 m^2 (10m x 4m).The lands were fertilized with 21-17-25-7-2-1 kg N-P-K-S-Zn-B ha^{-1}, respectively. Mustard was harvested on 27 February to 3 March 2017, whereas Field pea on 7-12 March, 2017. The yield of Field pea decreased with the increase of Mustard population and the yield of Mustard decreased with the increase of Field pea population in the mixed cropped situation. All the mixed cropping combinations showed superiority in terms of gross return, gross margin and field pea equivalent yield (FEY) than sole cropping. The highest field pea equivalent yield (1575.88 kg ha^{-1}) was found in the treatment combination of field pea (80 %) + mustard (20 %) and it gave the highest gross return (Tk. 78,794 ha^{-1}) and gross margin (Tk. 54,854 ha^{-1}). The sole crop of field pea (T_1) gave the lowest gross return (Tk. 64,790 ha^{-1}) and gross margin (Tk.40,470 ha^{-1}).

Mixed cropping of lentil and mustard under rainfed condition in high barind tract

The experiment was undertaken at Kadamshahar, Godagari, Rajshahi during 2015-16 and 2016-17 to study the effect of lentil (BARI Masur-6) and mustard (BARI Sarisa-15) mixed cropping in different plant population. The experiment was laid out in a randomized complete block design with three compact replications. The unit plot size was 10 m x 4 m. There were five treatments combination viz., T_1= Sole lentil (100%), T_2= Mustard (100%), T_3= 100% lentil + 10% mustard, T_4= 100% lentil + 20% mustard, and T_5= 100% lentil + 30% mustard. The variety of lentil and mustard were BARI Masur-6 and BARI Sarisa-15, respectively. Seeds of both crops were sown on first week of November in both years simultaneously. The fertilizer doses were 90-27-48-10-1-0.3 N-P-K-S-Zn-B receptively. The mustard crop was harvested on late January and lentil was harvested on late February. From the two year average result, mixed cropping of lentil and mustard (100% lentil + 10% mustard) gave the superior lentil equivalent yield (1.18 t ha^{-1}) in compared to sole lentil and other mixed cropped treatment. The maximum gross return and gross margin were also recorded in the 100% lentil + 10% mustard treatment that was followed by sole lentil T_1 (100% lentil).

Mixed cropping of field pea *(Pisum sativum)* with mustard *(Brassica Campsites)*

The field experiment was carried out at South Lemua, MLT site, Feni (AEZ 19a) during the Rabi season of 2016-17 to verify the performance of field pea as mixed crop with mustard. The treatment combinations used in the experiment were: T_1 = Sole Field pea (100 %) @ seed rate 50 Kg ha^{-1}, T_2 =Sole Mustard (100%) @ seed rate 10 Kg ha^{-1}, T_3 = Field pea (90%) + Mustard (10 %), T_4 = Field pea

(80 %) + Mustard (20 %) and T_5 = Field pea (70 %) + Mustard (30%). The experiment was laid out in Randomized Complete Block design with six dispersed replications. Seeds of Field pea (BARI Motor-1) and Mustard (BARI Sarisha-14) were broadcasted on 11 to 14 December 2016. The unit plot size was 40 m^2 (10 m × 4 m).The lands were fertilized with 21-17-25-7-2-1 kg N-P-K-S-Zn-B ha^{-1}, respectively. Mustard was harvested on 27 February to 3 March 2017, whereas Field pea on 7-12 March 2017. All the mixed cropping combinations showed superiority in terms of gross return, gross margin and field pea equivalent yield (FEY) than sole cropping. The highest Field pea equivalent yield (1575.88 kg ha^{-1}) was found in the treatment combination of Field pea (80 %) + Mustard (20 %) and it gave the highest gross return (Tk. 78,794 ha^{-1}) and gross margin (Tk. 54,854 ha^{-1}). The sole crop of Field pea (T_1) gave the lowest gross return (Tk. 64,790 ha^{-1}) and gross margin (Tk.40,470 ha^{-1}).

Performance of lentil under relay and conventional method

The trial was conducted at Multi Location Testing (MLT) Site, Atghoria, Pabna during the rabi season of 2016-17 to evaluate the performance of lentil under relay and conventional method at farmers' field. Two treatments viz. T_1= Seed sowing as relaying with T.*Aman* rice and T_2= Seed sowing under traditional tillage were tested in the study. The trial was laid out in RCB design with 4 dispersed replications. The unit plot size was 20 m x 12 m. Lentil variety BARI Masur-7 was used as planting material. Seeds were sown on November 02, 2016 and November 18, 2016 in relay system and traditional tillage system, respectively. Fertilizers were applied as per recommendation. Crop was harvested on 18 January, 2017 and 03 February, 2017 in relay system and traditional tillage system, respectively. Relay system provided significantly higher yield (1613 kg ha^{-1}) over conventional method. In terms of economic return, higher gross return and gross margin (106835 Tk. ha^{-1}) was also obtained from relay cropping of lentil.

Effect of rice stubble height in relay wheat with T.*Aman* rice

Relaying of wheat with T.*Aman* rice was evaluated at Multi Location Testing (MLT) Site, Atghoria, Pabna during the *rabi* season of 2016-17 to find out the optimum height of rice stubble and suitable sowing time for successful relay wheat production. The experiment was consisted of two rice stubble height viz. H_1= 10cm, H_2= 20cm and three seed sowing time of wheat viz. S_1= 15 days before T.*Aman* harvest (DBTH), S_2= 10 DBTH, S_3= 5 DBTH. The experiment was designed in RCB maintaining three replications. Wheat variety BARI Gom-26 was relayed with T.*Aman* cultivar Sharna. The unit plot size was 10m x 8m. Seed sowing was started from 17 November, 2016 and continued 5 days interval as per treatments. Matured T.*Aman* rice was harvested on 02 December, 2016 remaining the stubble height as per treatments and the heights were measured from soil surface. Fertilizers were applied as per recommendation. Treatment combination of rice stubble height and sowing date had significant effect on number of spikes m^{-2}, plant height (cm), number of spikelet $spike^{-1}$, number of grains $spike^{-1}$and grain yield. Significantly highest grain yield (3.63 t ha^{-1}) was obtained from 20 cm stubble height with the sowing time of 15 days before T.*Aman* harvest.

Performance of maize under zero tillage and conventional method

The experiment was carried out at FSRD site, Pushpopara, Pabna during the rabi season of 2016-17 to assess the performance of maize under zero tillage and conventional method at farmers' field. Two treatments viz. T1= Seed sowing under zero tillage (dibbling method) and T2= Seed sowing under traditional tillage were tested in the study. The trial was laid out in RCB design with 4 dispersed replications. The unit plot size was 10 m x 8 m. Maize variety NK-40 was used as planting material. Seeds were sown on December 08, 2016 and December 14, 2016 in zero tillage system and traditional tillage system, respectively. Fertilizers were applied as per recommendation. The crop was harvested on May 14, 2017 both in zero tillage system and traditional tillage system. Zero tillage system provided significantly higher yield (11.33 t ha-1) over conventional method. In terms of economic return, higher gross return (Tk. 209830 ha-1) and gross margin (Tk.141040 ha-1) was also obtained from zero tillage system of maize production.

Performance of wheat varieties relaying with T.*Aman* rice under T.*Aman*/Wheat–T. *Aus* cropping pattern

The trial was conducted at the MLT site Kushtia under OFRD, BARI, Kushtia during the years of 2015-16 to 2016-17 to select the suitable wheat variety for relay condition and to increase production and farmers income. The experiment was laid out in RCB design with three replications. The replications were three in both the years. The used wheat varieties were BARI Gom-26, BARI Gom-28, BARI Gom-29 and BARI Gom-30 for 2016-17 while BARI Gom-24, BARI Gom-26, BARI Gom-27 and BARI Gom-28 for 2015-16. Fertilizer was applied at the rate of 102-28-51-20-3.5-1 kgha^{-1} of NPKSZn and B, respectively. The height of stubbles was 10-15cm for maintaining sufficient soil moisture at seedling stage of wheat. BARI Gom-24, BARI Gom-26, BARI Gom-27, BARI Gom-28, BARI Gom-29 and BARI Gom-30 were used in the trial. Results revealed that the yield of BARI Gom-30 was the highest among all other varieties. The gross return and gross margin of BARI Gom-30 was also the highest in all other varieties.

Performance of early planted tomato under partial shade condition

Tomato is a temperature sensitive crop and thus minimizing high temperature through making partial shady environment is desirable. Mango orchard and Dhaincha (Sesbania aculeata) plantation was used for creating partial shady environment against open field condition in the experiment carried out at Agricultural Research Station, Alamnagar, Rangpur during late Kharif-II to early Rabi season of 2016-17. The treatments were T_1: Open field, T_2: Mango orchard, T_3: Dhaincha sowing in between all tomato rows (keeping whole crop duration), T_4: Dhaincha sowing in between alternate tomato rows (keeping in whole crop duration), T_5: Dhaincha sowing in between all tomato rows (cut down after tomato flowering), and T_6: Dhaincha sowing in alternate tomato rows (cut down after tomato flowering). Twenty days old dhaincha seedling grown in polybag was transplanted in every or alternate rows of the respective plot maintaining 80 cm plant to plant spacing during tomato transplanting.The age of mango trees (cultivar- Amropali, BARI Hybrid Aam-4 and Harivanga) were about 4-5 years old and the tree spacing was 4.4m × 4m. Seedlings of the variety BARI Hybrid Tomato-4 were transplanted on 02-04 October, 2016 maintaining the spacing 60cm × 40cm in a 3.6m × 3.5m sized plot (two beds/plot). Recommended fertilizers (275-105-150-13-1-1-5000 kg N-P-K-S-Zn-B-CD ha^{-1}) were used for tomato cultivation. Dhaincha plant was planted in every row or alternate row of tomato plant which was detopped in certain treatment after tomato flowering. Tomato cultivated in orchard environment produced more fruits per plant (12.05), single fruit weight (40.92 g) and fruit yield (13.89 t ha^{-1}) compared to open field and dhainch planted environment at early fruiting stage and during the later stage the trend was more or less same except the single fruit weight and finally the total fruit yield stranded 47.17 t ha^{-1} in orchard environment followed by 39.66t ha^{-1} in every row undetopped dhaincha (ERUD) plot where 30.68 t ha^{-1} in open field condition. Shady environment in orchard or dhaincha plot reduced the tomato canopy temperature by 1-2°C, which influenced tomato plant growth especially the plant height in all shady plots compared to open field condition. Higher economical profit was obtained from mango orchard (gross margin 980329 Tk. ha^{-1}) followed by ERUD plot (gross margin 698912 Tk. ha^{-1}) than open field or other conditions, and it was mainly contributed by higher tomato fruit yield with higher market price from early harvestruiting stage. Thus, partial shady environment at early growth stage of early planted tomato was found suitable as well as profitable.

Effect of planting time on quality seed production of onion in charland

A field experiment was conducted at Multi-location testing (MLT) site, Ulipur, Kurigram during the year of 2016-17 to find out the optimum planting time for maximizing quality true onion seeds production. The experiment was laid out in a randomized complete block design with six replications. BARI Piaj-1 was used for the experiment. Randomized complete block design with six replications were used for the experiment. The treatments were five planting dates viz. T_1= 15 October, T_2=1

November, T_3= 15 November, T_4= 01 December and T_5= 15 December. The unit plot size was 3m × 3 m having 25 cm line distances with 20cm plant to plant distance. Onion seed was sown in the field five times from 15 October with 15 days interval to find out suitable seed production sowing date. The crop was fertilized @ 120-53-85-20-2 kg ha^{-1} of N-P-K-S-Zn and 5 t cowdung, respectively.The results showed that the growth parameters, seed yield components, health and quality of harvested seeds were significantly influenced by the different dates of planting. Among the planting dates, 1 November was the best for quality onion seed production.

Performance of different short duration vegetables under bottle gourd trellis

An experiment was conducted at the farmers' fields of Syedpur, Adarsha Sadar and Durgapur, Burichang of Comilla and Kharera, Koshba of B. Baria during the rabi season of 2016-17 to find out suitable short duration vegetables to grow under bottle gourd trellis for increasing the production and income of the farmers in this region. Under bottle gourd (BARI Lau-3) trellis, BARI developed vegetables variety BARI Lalshak-1, BARI Palongshak-1, BARI Mula-1, BARI Data-1 and commercial hybrid carrot were used as under storey crop in this experiment. The experiment was laid out in a Randomized Complete Block (RCB) Design with Four dispersed replications. The unit plot size was 5 m 2 m. The spacing was 20 cm × 5 cm for radish and 30 cm × continuous for carrot while other three were broadcasted. Highest combined yield (86.98 t ha^{-1}), total gross return (1005989 Tk. ha^{-1}), net return (873989 Tk. ha^{-1}) and BCR (7.62),were found from radish + bottle gourd combination and the lowest from red amaranth + bottle gourd combination (579973, 450973 Tk. ha^{-1} and 4.5, respectively).

Effect of planting system on the yield of chilli at coastal area

The experiment was conducted at MLT site, Kuakata, Patuakhali during the Rabi season of 2016-2017 to find out suitable planting system for chilli in coastal saline area. Three planting methods viz. T_1= 40 days old uprooted seedling, T_2= 40 days old polybag seedling, and T_3= Direct seed sowing were tested in the trial. The experiment was laid out in a randomized complete block design having unit plot size 8 m × 5 m with three replications. Seeds of BARI Morich-1 and 40 days old seedlings were sown/transplanted at 02 January 2016. Seeds were sown continuously in line. Seedlings were transplanted at a spacing of 75 cm × 20 cm. Fertilizers were applied as recommended in FRG 2012. Weeding and other intercultural operation were done as and when necessary. Fruits harvest of different treatments was completed on 17 May 2016. It was found that transplanting of 40 days old polybag seedlings was better than other methods. The highest dry fruit yield (2.51 t ha^{-1})was found from 40 days old polybag seedlings transplantation and the lowest yield was obtained from direct seedling (1.1 t ha^{-1}).The highest benefit was also found from 40 days old polybag seedlings transplantation (Tk. 153160 ha^{-1}) followed by 40 days old uprooted seedlings transplantation (Tk. 142160 ha^{-1}).

Performance of maize under different tillage options in drought prone environment

An experiment was conducted at the farmer's field of Shibpur, Puthia, Rajshahi during the rabi season of 2015-2016 and 2016-17 to study the performance of maize under different tillage option. The experiment was laid out in a randomized complete block design with four replications comprising of four treatments viz. T_1: Strip tillage, T_2: Dibbling method, T_3: Bed planting and T_4: Farmers' practice. In case of dibbling, maize seed were sown just 2-2.5 cm soil depth under no tillage condition by making a small hole. Farmers' practice of land preparation included 3 times tillage followed by laddering. The unit plot size was 6 m × 5 m. The seeds of BARI Hybrid Bhutta-9 @ 25 kg ha^{-1} were sown by keeping 60 cm × 20 cm on 23 Nov 2016. The lands were fertilized with 253-52-110-47-5-1, N-P-K-S-Zn-B kg ha^{-1} + 5 ton CD. Better establishment of the crop from the RCT based tillage systems positively contributed to yield and yield components of maize. However, among the treatments maximum grain cob^{-1} (672.1), grain weight cob^{-1} (155.8 g) and grain yield (11.22 t ha^{-1}) were recorded from dibbling method of planting. From the economic point of view, higher yield in the RCT based tillage options contributed to higher economic return than conventional practice. However, the highest gross margin (Tk. 132040 ha^{-1}) and BCR (3.17) were obtained from dibbling method followed by strip tillage. Conventional practice showed comparatively poor performance in terms of both yield and economic return.

Effect of different mulching techniques on the yield of pointed gourd in AEZ 12

A trial was conducted under farmer's field situation at the MLT site, Rajbari during the year of 2015-16 to find a mulching technique suitable for growing pointed gourd. The trial was laid out in a Randomized Complete Block design with seven (7) dispersed replications. There were three treatments viz., T_1= Open field + Rice Straw mulch (5 t ha^{-1}), T_2= Open field + Rice Straw mulch (3 t ha^{-1}) T_3= On trellis (Farmers' practice).Variety BARI Patal-2 was used as planting material. The plot dimension was 4.5m 4.5 m and spacing was 1.5 m 1.5 m. The crop was fertilized with $N_{120}P_{24}K_{24}S_{15}Zn_2B_1$ kg ha^{-1}. The crop was fertilized with $N_{120}P_{24}K_{24}S_{15}Zn_2B_1$ kg ha^{-1}. Entire amount of cowdung, TSP, MoP, gypsum, Zinc sulphate, boric acid were applied during pit preparation, five days before sowing. Urea was applied in 4 equal installments at 5-8 (due to cool temperature resulting late sprouting of vine), 10-12, 15-16 and 18-19 weeks after seedling germination. The vine was planted on 26 November to 6 December 2015 and harvesting of fruit was started from 147-157 DAT and continued for next 88 days.The highest fruit yield (26.22 t ha^{-1}) was obtained from farmers' practice but the highest gross margin (Tk. 228650 ha^{-1}) and BCR (2.58) was calculated from open field with 3 t ha^{-1} rice straw mulch.

Effect of irrigation on groundnut yield at the charlands of Bhuapur, Tangail

An experiment was conducted at the charland of Jamuna river under Bhuapur upazila, Tangail during the rabi season of 2015-16 to evaluate the effect of irrigation on the yield of groundnut and increase yield and economic return of farmers. BARI Chinabadam-8 was selected as variety with four irrigation treatments viz., I_1= Irrigation at flowering stage, I_2= Irrigation at kernel/ pod initiation stage, I_3= Irrigation at flowering and pod initiation stages and I_4= Non- irrigated. The experiment was laid out in a randomized complete block design with 3 replications. Seeds were sown on 25 to 27 November 2016 in line with 30 cm × 15 cm spacing. The unit plot size was 40 m^2. The crop was fertilized with 12-32-43-54-2 kg ha^{-1} N-P-K-S-B,respectively (Recommended fertilizer dose based on AEZ). Seed rate was 100 kg ha^{-1}. The crop was harvested during 7-9 May 2017. Considering two years average, the highest pod yield (2.28 t ha^{-1}) was obtained from I_3. The highest gross margin was obtained from I_3 (Tk. 64274 ha^{-1}) and lowest gross margin (Tk. 44657 ha^{-1}) was obtained from I_4. I_3 produced 35.57% higher yield compared to I_4 (non-irrigated).

Performance of potato planter and harvester in Rajshahi region

A field trial was conducted at MLT site, Shibpur, Puthia, Rajshahi during the Rabi season of 2016-17 to evaluate the performance of potato planter and harvester for potato cultivation in the farmers' field. The trial consisted of two methods for potato cultivation namely, T_1: Potato planting and harvesting by using potato planter and harvester, respectively (mechanical method) and T_2: Farmers' practice (conventional method). The experiment was designed with six dispersed replications (in six different farmer's field). The unit plot size was 800 m^2. The potato tuber was planted on 20-22 November 2016 following 1500 kg ha^{-1} seed rate as per treatment specification. In these trials average seed size of 35mm (diameter) used for cup type planter. Cup type planter can form one bed of 60 cm size per pass. The tested variety was Diamont. The land was prepared well with 3-4 ploughing followed by laddering. The nutrient rates were 140-19-96-10-4-1.5 for N-P-K-S-Zn-B, respectively. The sources of nutrients were urea for N, TSP for P, MoP for K, Gypsum for S, Zinc sulphate for Zn and Boric acid for B. The entire amount of P, K, S, Zn, B and half of N were applied during the final land preparation. The rest N was applied 35 day after planting (DAP) followed by earthing up. Irrigation and other intercultural operations were done in order to support normal growth of the crop. Potato was harvested on 24-28 February in 2017. There was no significant yield difference between mechanical and conventional methods. Potato yield in mechanical method was slightly higher than manually planted method. Potato planter required 4 man-days ha^{-1} compared to 70 man-days ha^{-1} in conventional planting method and the planter saved 94% labour in potato planting. Labour requirement for harvesting in case of harvester and conventional method were 25 man-days and 75 man-days ha^{-1}, respectively and 66% labour was saved for using potato harvester. Considering the labour requirement in whole potato cultivation process, 50% labour was saved in mechanical method. Production cost was higher in conventional potato cultivation method (Tk. 121755 ha^{-1}) while gross margin (Tk. 130995 ha^{-1}) and benefit cost (2.25) ratio were higher in mechanical method.

Performance of early planted tomato varieties under agroforestry system

Mango orchard based agroforestry systems research was conducted with tomato at Agricultural Research Station, Alamnagar, Rangpur during the late Kharif-II to Early Rabi season of 2016-17 to evaluate the suitability and performance of BARI developed summer hybrid tomato varieties and lines in early planting condition. Two newly developed advance tomato lines (T_3=CLN-3324A × CLN-3125-O-19, T_4=CLN-3150-A-5 ×CLN-3125-O-19) along with T_1=BARI Hybrid Tomato-4 and T_2=BARI Hybrid Tomato-8 were tested under mango orchard and open field environment maintaining RCB design with split plot arrangement in three replications. The age of mango trees (cultivar-Amropali, BARI Hybrid Aam-4 and Harivanga) were about 4-5 years old and the tree spacing was 4.4 m × 4 m. Tomato seedlings were transplanted on 02 October, 2016 maintaining the spacing 60 cm × 40 cm in a 3.6 m × 3.5m sized plot (two beds/plot). Recommended fertilizers (275-105-150-13-1-1-5000 kg N-P-K-S-Zn-B-CD ha^{-1}) were used for tomato cultivation. The taste of early planted tomato particularly in open field condition was relatively sourer as the total soluble solids decreased (4.02%). Tomato cultivated in mango orchard environment produced more fruits per plant (7.21), weight per fruit (75.82 g) and fruit yield (13.09 t ha^{-1}) compared to open field environment at early fruiting stage. Similar trend was also found in the later stage except the single fruit weight and finally the total fruit yield stranded 45.69 t ha^{-1} in orchard environment and 31.24 t ha^{-1} in open field condition. Mango tree shade cut light intensity 87.83% and 78.56% in the morning and noon, respectively and it minimized the canopy temperature about 8.22% at 45 days after transplanting (DAT) continuing of early hot period. Among the tested lines and varieties, the highest number of fruits per plant was obtained from BARI Hybrid Tomato-4(9.63) at early fruiting stage and at later stage it was also the highest in BARI Hybrid Tomato-4 (25.41). The highest total fruit yield (46.10 t ha^{-1}) was obtained from new line CLN-3150-A-5 × CLN-3125-O-19 and the lowest yield (29.91 t ha^{-1}) was obtained from BARI Hybrid Tomato-8. Higher economical profit was obtained from mango orchard (gross margin 935335 Tk. ha^{-1}) than open field condition (gross margin 511385 Tk. ha^{-1}), and it was mainly contributed by higher tomato fruit yield with higher market price at early fruiting stage. Early tomato production is profitable due to high market demand and price, but during the vegetative growth to early fruiting stage the prevailing high temperature hampered the growth and yield of tomato. If the temperature can be minimized by any way like, agroforestry system, tomato can be produced early and profitably. New line CLN-3150-A-5 × CLN-3125-O-19, CLN-3324A × CLN-3241AA and BARI Hybrid Tomato-4 may be a good option for production in early season. However, further trial is required for more confirmation.

Assessment of potato losses due to infestation of root aphid (*Pemphigus sp.)* in potato growing areas of Joypurhat

A field survey was conducted at different locations namely, Nischinta, Punot, Komorgram and Dogachi of Joypurhat districts during the year of 2016-17 to determine the intensity of infestation of root aphid. The study was carried out in four potato growing locations of Joypurhat during 2016-17. Fields were visited at different growth stages of the crop after tuber formation to collect information about the incidence of root aphid. A total of 175 (100 from Punot and 25 from each of other three locations) randomly selected farmers were interviewed with objective oriented questionnaire. Some fields were observed by the team to record their nature of infestation.About 100% of the sampled farmers were familiar with the pest in Nischinta and Punot areas but only 10% and 20% were familiar in Komorgram and Dogachi, respectively. According to farmers' perception, yield loss by the pest was 10-35%. Farmers sprayed different insecticides 3 to 4 times to combat the pest. This is a new pest for potato in Bangladesh, its management strategies need to be developed.

Effect of ash on yield of wheat, lentil and mustard

A study was conducted at the farmer's field of the MLT site Kushtia during 2016-17 to find out the effect of ash on the yield of wheat, lentil and mustard. There were five treatments viz. T_1: STB fertilizer dose, T_2: T_1+ 1 t ha^{-1} ash, T_3: T_1 + 1.5 t ha^{-1} ash, T_4: T_1+ 2 t ha^{-1} ash and T_5: Farmers' practice. Variety BARI Sarisha-14, BARI Masur-6 and BARI Gom-28 was used in the experiment. In case of mustard, lentil and wheat crops were sown on 06 November 2016 and was harvested on 01 February 2017, sown on 07 November 2016 and crop was harvested on 28 February 2017, sown on 18-19 November 2016 and harvested during 15-16 March 2017, respectively. Required amount of ash, half of urea and full amount of other chemical fertilizers were applied as basal. In case of mustard treatment T_4 offered the highest yield (1657 kg ha^{-1}) which was statistically similar with T_3 (1560 kg ha^{-1}) similar trend was found in wheat. The treatment T_4 (4.43 t ha^{-1}) gave maximum yield which was statistically similar with the rest treatments except T_5 (3.81 t ha^{-1}). On the other hand, in lentil treatment T_3 offered the highest seed yield (1430 kg ha^{-1}) which was statistically similar with the rest treatments except T_1 (1313 kg ha^{-1}). Similar result was also observed in case of straw yield.

Performance of high yielding varieties of mustard in mustard- boro rice mixed cropping system in Comilla region

A field experiment was conducted at MLT site, Debidwar, Comilla and Hatila, Chandpur during the rabi season of 2016-17 to find out a suitable HYV mustard variety for increasing yield and income in Mustard- Boro rice mixed cropping system. The experiment was laid out in RCB design with 5 dispersed replications. Four different treatments, i.e. T_1= 100 % Boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-9, T_2 = 100 % Boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-14, T_3 = 100 % Boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-15, T_4 = 100 % Boro rice (Var. BRRI dhan29) + 100 % BARI Sarisha-17, along with T_5 = Farmers' practice (Var. BRRI dhan29 or Tori-7) were used in the experiment. All materials of the treatments were applied following broadcasted method. The experiment was set on 25-26 November 2016 @ 8 (mustard) and 40 kg ha^{-1} (rice) respectively. The unit plot size was 100 m^2. The lands were fertilized with 18.43, 16, 20, 7, 1.43 and 1.36 kg N-P-K-S-Zn-B ha^{-1}, respectively. 2/3rd of urea and all the fertilizers of entire amount were applied during final land preparation as basal and rest 1/3rd of urea was applied as top dress at 30 days after broadcasting. Plant protection measure and all other management practices were done for mustard and boro rice as and when necessary. Mustard was harvested on 8-9 February 2017 whereas boro rice on 19-20 April 2017. The highest rice equivalent yield (9.55 t ha^{-1}) was found in the treatment combination T_4 where 100 % Boro rice (Var. BRRI dhan29) plus 100 % BARI Sarisha-17 were mixed cropped. Cost and return analysis revealed that the combination of BRRI dhan29 plus BARI Sarisha-17 (T_4) gave the highest gross return (143250.00 Tk. ha^{-1}) and gross margin (70710.00 Tk. ha^{-1}) compared to the other mixed cropped combinations and it was also superior from sole cropping of boro rice or sole mustard. Based on the research result it may be concluded that 100% Boro rice (Var. BRRI dhan29) + 100% BARI Sarisha-17 and 100% boro rice (Var. BRRI dhan29) + 100% BARI Sarisha-14 are the suitable combinations for mustard-boro rice mixed cropping system in Comilla region for earning higher benefit.

Effect of tillage options and schedule spray on the performance of lentil in AEZ-11

The program was conducted at farmers' field of Shibpur, Puthia, Rajshahi during the rabi season of 2015-16 and 2016-17 to see the performance of lentil under different tillage options with or without spray condition. The experiment was laid out in RCB design with three replication and comprising of six treatments i.e. T_1: Conventional tillage+ no spray, T_2: Bed planting+ no spray, T_3: Strip tillage+ no spray, T_4: Conventional tillage+ schedule spray, T_2: Bed planting+ schedule spray, T_3: Strip tillage+

schedule spray. The unit plot size was 8m × 5m. Seeds of BARI Masur-7 @ 40 kg ha^{-1} were used for the experimentation. The land was fertilized with 23-18-20-1 N-P-K-B kg ha^{-1} (FRG, 2005) in the form of urea, triple super phosphate and muriate of potash, respectively. All fertilizers were applied as basal after final land preparation. Three times spray with Rovral @ 2 g L^{-1} were done at the time of flowering to pod development by maintaining 10 days interval. Intercultural operations like, weeding and irrigation were done for normal growth of the crop. First year, seeds were sown on 18 November 2015 and harvested on 9 March 2016 during 2015-16 while in the 2^{nd} year, seeds were also sown on 23 November 2016 and harvested on 13 March 2017. Lentil showed a good response to tillage machinery based seeding systems along with schedule spray over the conventional tillage with no spray condition. All the yield contributing parameters like, pod $plant^{-1}$, branch $plant^{-1}$, 1000 seed weight were higher in machinery based scheduled spray condition than that of conventional practice. Similarly grain yield was comparatively high in seeder based tillage option. Among the seeding machinery, Bed planting with schedule spray contributed to the maximum grain yield (2.14 t ha^{-1}). Farmers opined that bed planter seeding coupled with three times spray was helpful for increasing yield of lentil. CA machinery based seeding options conserved residual soil moisture at the crop root zone which was helpful for seed germination, plant establishment and further growth and development of the crop. From the results of the study it may concluded that bed planting with three times spray should be a good option for yield intensification. Higher economic return was achieved from mechanized cultivation as reduced cultivation cost contributed to higher gross margin and BCR over the conventional system

Effect of water stress at different growth stages on the yield of mustard

This experiment was conducted at the farmer's field of Shympur, Rajshahi during the rabi season of 2015 - 2017 with BARI Sarisha-14. There were five irrigation treatments, each replicated thrice in a randomized complete block design. Basin irrigation method was used. It was found that deficit irrigation (DI) utilized less seasonal water use to produce the optimum yield, and highest water productivity, percentage water saved, and net return in compared to full irrigation. Five irrigation treatments were replicated thrice with randomized complete block (RCB) design. The treatments were T_1 = Full irrigation at pre-flowering (25-30 DAS) and pod formation (50-55 DAS) stage, T_2 = $DI_{80\%}$ up to FC at pre-flowering (25-30 DAS) and pod formation (50-55 DAS) stage, T_3 = $DI_{60\%}$ up to FC at pre-flowering (25-30 DAS) and pod formation (50-55 DAS) stage, T_4 = $DI_{80\%}$ at pre-flowering (25-30 DAS) stage and T_5 = $DI_{80\%}$ at pod formation (50-55 DAS) stage. Fertilizers were applied at the rate of N_{104}, P_{29}, K_{75}, S_{24}, $Zn_{2.1}$, $B_{0.85}$ kg ha^{-1} and cowdung 5.0 t/ha. Two- thirds of N and total amount of other fertilizers and cowdung were applied at the time of final land preparation and the remaining N was applied as top dresses after first irrigation. Seeds were planted in line on 8 November, 2015 and 5 November, 2016 at Rajshahi at the rate of 7 kg/ha. The unit plot size and spacing were 4.8 m × 3.9 m and 30cm × 15cm, respectively. This irrigation technique reduced some plant growth parameters (biomass and LAI) in compared to full irrigation. Seasonal water use was found for Rajshahi it was 116.05mm and 144.4 mm. The treatment ($DI_{80\%}$ at pre-flowering stage) saved more than 50% water to produce 1.57 t/ha and 1.49 t/ha for Rajshahi two consecutive years, This treatment also gave the highest net return of Rajshahi, it was 0.70 lakh 0.43lakh Tk. per ha of land for two years. From this study, it can be said that BARI Sarisha-14 at $DI_{80\%}$ at pre-flowering stage can produce the optimum yield for water scarce regime if soil moisture at the sowing time is at the available condition. This treatment also matured early and can be treated suitable for increasing cropping intensity under water scarce region in Bangladesh. Deficit irrigation is a water saving technique where water required less than the crops actual need and saved water can be utilized to irrigate another field. This technique is really helpful in areas where is water is scarce to fulfill the crop water need. From the results, it can be concluded that applying irrigation at 80% of field capacity at pre-flowering stage utilized less seasonal water to produce the optimum yield, and showed higher water productivity, percentage water saved, and net return as compared to full irrigation. Though the deficit irrigation ($DI_{80\%}$ at pre-flowering stage) little bit reduced growth parameters of biomass and leaf area index in compared to full irrigation at all growth stages. However, this single irrigation would be optimum for getting satisfactory yield of BARI Sarisha-14 if crop is planted at suitable soil moisture condition during the rabi season in Rajshahi. Moreover, due to single irrigation, this crop can complete its cycle within 70-80 days which results to increasing cropping intensity.

Management of common scab disease of potato at farmers field in Mymensingh

An experiment was conducted at farmers' field of Gouripur, Mymensingh during the rabi season of 2016-17 to find an effective management for controlling common scab of potato. The potato variety BARI Alu-8 (Cardinal) was used as a testing material. Three treatments were: T_1 = seed treatment with 3% boric acid, T_2 = seed treatment with 0.3% mancozeb and T_3 = farmers' practice (untreated) was used as check in this experiment. The experiment was conducted at randomized complete block design with three replications. The unit plot size was 5 m 6 m. Potato tubers were sown on 23 November 2016 maintaining a spacing of 60cm 25cm. the fields were fertilized with 150-45-130-15 Kg ha^{-1} of N, P, K and S in the form of urea, TSP, MOP and gypsum, respectively along with cowdung @ 10 tha^{-1}. The potato variety BARI Alu-8 (Cardinal) used as a testing material. The crop was harvested on 23 February 2017 at 92 DAP.

Incidence of common scab under different treatments was calculated following the formula stated below-

Common scab incidence (%) = $\dfrac{\text{Number of infected tuber/plant}}{\text{Total number of tuber/plant}} \times 100$

The experiment was laid out in a randomized complete block design with three replications. Out of three treatments, T_1 showed the lowest (14.17%) scab incidence and highest (29.0 tha^{-1}) tuber yield. The highest (23.86%) scab incidence was observed in T_3 with lowest (23.7tha^{-1}) tuber yield. Results of the study suggest that seed treatment with 3% boric acid is an effective measure against scab and thus produced maximum tuber yield with minimum disease incidence. The maximum gross return (4,64,000 Tk. ha^{-1}) and gross margin (Tk. 3,18,880ha^{-1}) were also recorded from T_1. Based on the research findings, it may be concluded that seed treatment with 3% boric acid before sowing is the best management approach for controlling common scab incidence with higher tuber yield as well as highest gross return and gross margin. This is the result of only one season experiment. Therefore, the study needs to be repeated to draw a valid conclusion.

Effect of different antibacterial materials on bacterial wilt of brinjal at char lands of Jamalpur

An experiment was carried out at charlands of Multi-Location testing site, Malancha, Melandah, Jamalpur during the Rabi season of 2016 2017 to know the effect of different antibacterial materials on bacterial wilt of brinjal. Local variety (Bottle begun) was used in the study. Five treatments were included in the study such as: T_1=Recommended dose of chemical fertilizers (RD) + stable bleaching powder @ 25 kg ha^{-1} with cowdung 5 t ha^{-1}, T_2= Recommended dose of chemical fertilizers (RD) + poultry refuse @ 3 t ha^{-1} with 5 t ha^{-1} cowdung, T_3=Recommended dose of Chemical fertilizers (RD) + mustard oilcake @ 500 kg ha^{-1} with cowdung 5 t ha^{-1}, T_4= Recommended dose of chemical fertilizers (RD) + furadan @ 25 kg ha^{-1} with 5 t ha^{-1} cowdung, T_5= Farmers' practice. Results clearly indicated that recommended dose of chemical fertilizers (RD) + staple bleaching powder @ 25 kg ha^{-1} significantly influenced brinjal production. The seeds of brinjal were sown in the seed bed on August 01, 2016. Seedlings were transplanted in the main field on September 12 2016. The unit plot size was 5 m × 4 m having 50 cm × 50 cm plant spacing. The crop was harvested started on 18 October 2016 and continued up to 02 January 2016. A wide range of variation in yield and yield attributes was observed among the treatment combinations. The highest fruit yield (55.30 t ha^{-1}) was recorded from recommended dose of chemical fertilizers (RD) + staple bleaching powder @ 25 kg ha^{-1} and lowest yield (35.56 t ha^{-1}) was obtained from farmers' practice.

Effect of funcides in controlling leaf spot, leaf rot and vine rot of betel leaf

The experiment was conducted at the MLT site, Bagerhat during the year of 2015-16. The experiment was laid out in randomized complete block design with three dispersed replications using six treatments viz. T_1: Trooper (0.75g/L)+Ripcord (2g/L), T_2: Trooper (0.75g/L)+ Bavistin (1g/L), T_3: Filia (2ml/L), T_4: Tinsem (2g/L), T_5: Trichoderma (2g/L) based bio-fungicide and T_6: control. Betel vine variety 'Mohanoli' was used in the experiment. Each betel vine field (locally known as boroz) size was 40 sq. m. The crop was fertilized with N, P, K and B @ 92, 30, 75 and 1 kg ha^{-1} in the form of urea, TSP, MoP, and boric acid. All fertilizers except urea were applied as basal during final land preparation and urea was top dressed 4 times keeping two months interval. Pre-established farmers' fields were selected to set up the experiment. The crop was irrigated when required and the source of irrigation was ground water. All agronomical practices such weeding, mulching and earthing up were done as per necessity. The yield and yield contributing characters were recorded from randomly selected 10 plants. The lowest incidence of leaf spot (1.60%), leaf rot (1.92%) and vine rot (5.79%) was recorded from trichoderma based bio-fungicide treated field. Similarly, the highest yield (30.51 (t ha^{-1}), gross margin (Tk. 6621219 ha^{-1}) and BCR (1.98) was also obtained from the same treatment. The lowest yield was recorded from control treatment (18.53 t ha^{-1}) but the lowest gross margin (Tk. 4006878 ha^{-1}) and BCR (1.59) was calculated from T_1 (Trooper+Ripcord). Comparing treatment effect on the betel leaf diseases and yield, it may be concluded that Trichoderma based bio-fungicide is the best for controlling the diseases. This bio-agent is economically viable and eco-friendly bec*Aus*e it has no toxic effect on living being and environment. Moreover, the bio-fungicide has no harmful effect like chemical fungicides on human health even if betel leaf is chewing as raw/fresh.

Management of common cutworm in aroids at farmers' field condition

An experiment was conducted at the MLT site, Joypurhat during the year of 2016-17 to verify the performance of integrated management practice against common cut worm in aroid under farmer's field condition. The experiment was laid out in a RCBD with 6 dispersed replications. The variety was BARI Panikachu-2. The unit plot size was 40 bigha and total area 240 bigha. There were two treatments viz. T_1: IPM Approach (Pheromone trap + Collection and destruction of egg masses & larvae+ application of SNPV @ 0.2 g/L of water) and T_2:Farmers practice (with insecticide- Morter 48 EC (Chlorpyriphos) @ 2ml/L of water, 10 times spray at 7 days interval). Traps were placed uniformly throughout each field with equal spacing of 20m × 20m between traps. The seedlings were transplanted on 15 December 2016 to 10 January 2017. The trap was set on 20-28 February 2017. For the fulfillment of scientific conditions of the sex pheromone, farmers' practice plot was placed 500 m away from the sex pheromone plot. The harvesting was started 28th January 2017 and continued up to 10 June 2017. Crop under pheromone trap based IPM approach resulted comparative lower leaf and stolon damage and produced higher stolon (21.37 t ha^{-1}) and rhizome yield (21.90 t ha^{-1}) than farmers practice (with insecticide).

Integrated management for controlling tomato fruit borer

An experiment was conducted under farmers' fields at farming system research and development (FSRD) site, Jalalpur and multi-location testing (MLT) site, Moulvibazar during the winter season of 2016-2017 to find out effective management of tomato fruit borer for producing quality tomato. The treatments comprised of T_1: Pheromone mass trapping; T_2: Pheromone mass trapping + spraying of HNPV @ 0.1 g/L of water and SNPV @ 0.2 g/L of water; T_3: Pheromone mass trapping + spraying of Spinosad (Success 2.5SC) @ 1.2 g/L of water; T_4: Farmer's practice (FP)-spray with Imidacloprid (Admire 200SL) @ 0.5 ml/L of water + Thiamethoxam (Voliam flexi 300SC) @ 0.5 ml/L of water and T_5: Untreated control. The randomized complete block design was followed with three dispersed replications in each location. The unit plot size was 20 m × 10 m with maintaining the spacing of 60 cm × 40 cm. The lowest fruit infestation was obtained from T_2 (pheromone mass trapping + spraying of HNPV @ 0.1 g/L and Spraying of SNPV@ 0.2g/L of water). The highest fruit yield (43.93 t ha^{-1}), additional income over farmers practice, net income and marginal benefit cost ratio (2.21) was also obtained from T_2. From findings of the trial it may be concluded that pheromone mass trapping + spraying of HNPV (0.1 g/L) and SNPV (0.2 g/L) of water against tomato fruit borer could be considered as a good approach.

Management of wilt disease of brinjal in the farmers field

An experiment was conducted at farmers field under South surma upazila of sylhet and multi-location testing (MLT) site, Moulvibazar during the rabi season of 2016-17 to find out the management strategy for controlling bacterial wilt in eggplant (Solanum melongena L.) in acidic soil of Sylhet for increasing farmers' income. The experimental design was RCB with six dispersed replications. There were seven treatments viz., T_1: Poultry refuse @ 3 t ha^{-1}; T_2: Dolomite lime @ 1 t ha^{-1}; T_3: Stable bleaching powder @ 20 kg ha^{-1}, T_4: T_1+ T_2 ; T_5: T_1+ T_3 ; T_6: T_2+ T_3 ; T_7: Control. The unit plot size was 8 m × 5 m. The pit was prepared by maintaining spacing 100 cm × 75 cm. Standard cultural practices were followed and recommended basal dose of fertilizer nutrients 173-30-125-18 kg ha^{-1} N-P-K-S and cow dung (10 t ha^{-1}) were applied during final land preparation in all the trial plots. Thirty days old locally popular eggplant cv. Purple king (clustered bearing cylindrical fruiting type, highly susceptible to bacterial wilt disease) seedlings were transplanted in each plot on 12-16 November 2016 and fruit were harvested up to 20-25 April 2017. After transplantation, the brinjal plants in each plot were examined periodically.The field results indicated that the significant variation in percent infested plants was found under diffident treatments. Among different soil amendments, application of dolomite lime (1 t ha^{-1}) along with bleaching powder (20 kg ha^{-1}) followed by poultry refuse (3 t ha^{-1}) with bleaching powder (20 kg ha^{-1}) one month before transplanting were found most effective as showed much lower percent (58.65% and 44.48%, respectively) of infestation over the control. The treatment having dolomite lime along with bleaching powder contributed higher fruit yield (38.49 t ha^{-1}), gross return (Tk. 461880 ha^{-1}) and gross margin (Tk. 309055 ha^{-1}) in farmer's field.

Effect of fungicides against gummy stem blight (*Didymella bryoniae*) disease of bottle gourd

The study was conducted at Mahinonda village, Sadar upazila, Kishoreganj during the rabi season of 2015-16 and 2016-17 to evaluate the efficacy of fungicides on gummy stem blight disease of bottle gourd. The trial consisted of four treatments viz; T_1: Farmers' practice, T_2: Cuper fungicide, T_3: Tebuconazole and T_4: Tebuconazole with trifloxystrobin. The unit plot size was 15m × 4 m. The age 27 day's seedlings were sown on 6 August, 2015 and on 10 August 2016, respectively in the pit on raised bed to avoid water lodging condition and 8 seedlings were transplanted in each bed. At the time of land preparation 25 kg staple bleaching powder was used for soil treatment. Fertilizers at the rate of P_{20}, K_{25}cow dung 10 t ha^{-1}and 5 kg ash pit^{-1} were used at seedling transplanting and from 30 days after transplanting $N_{78}P_{22}K_{55}S_{20}$ kg ha^{-1} were used in the whole growing period. Harvesting was started on 16 October 2015 and continued on 31 March 2016 and on 12 October to 25 December 2016. Considering two years performances, the lowest disease infestations were found in T_4 treatment and the highest disease infestations were obtained in T_1 treatment closely followed by T_2. The maximum fruit yield 37.91 t ha^{-1}, gross return (Tk. 379100 ha^{-1}), gross margin (Tk. 214100 ha^{-1}) and the highest MBCR 14.34 were obtained from T_4 in 2016-17.

Performance of winter vegetables under fruit tree based agroforestry system

An experiment was conducted at the farmers' fields of Burichang and Daudkandi of Comilla and Koshba of B.Baria during the Rabi season of 2016-17 to evaluate the performance of cauliflower, cabbage, tomato and brinjal under mango based agroforestry system, to increase the production and income of the farmers in this region. The unit plot size was 4 m 7 m. The spacing was 60 cm × 45 cm for cabbage and cauliflower, 60 cm × 40 cm for tomato and 1 m × 80 cm for brinjal. Land was prepared by three times ploughing followed by laddering. Soil test based fertilizer dose for every crop and location were used. The seedlings were planted on 22 November to 05 December 2016. Insecticide and fungicide were sprayed as and when necessary to control the pest and diseases.

Cauliflower harvesting was started from 09 January 2017 and continued up to 19 January 2017. Cabbage was harvested during 7- 26 February 2017. Tomato and brinjal harvesting was started at 15-28 February 2017. Highest yield (45.747 t ha^{-1}), gross return (665943 Tk. ha^{-1}), net return (537110 Tk. ha^{-1}) and BCR (5.17) were found from tomato cultivation and the lowest from brinjal (12.647 t ha^{-1}, 291750 Tk. ha^{-1}, 168350 Tk ha^{-1} and 2.36, respectively). It may be concluded that tomato (BARI Tomato-15) is the best among the four tested crops. It was first year trial, so, it may be repeated for the confirmation of the result.

Feasibility of growing shade tolerant crops in mango orchard under agroforestry system

The agroforestry based experiment was conducted in mango orchard at Farming System Research and Development (FSRD) site, Pushpapara, Pabna during the year of 2016-17. Two vegetable crops and one spice crops viz. T_1= elephant foot yam, T_2= Turmeric and T_3= sweet gourd were considered as treatments in mango orchard in this trial. The experiment was carried out in RCB design with three replications. The plot size was 5 m × 4 m. Spacing were 1 m × 1 m for elephant foot yam, 50 cm × 25 cm for turmeric and 2.5 m × 2 m for sweet gourd, respectively. Elephant foot yam, Turmeric and Sweet gourd were sown on 5^{th}, 16^{th}, 5^{th} May 2016, respectively. Fertilizers were applied as per FRG'12. Crops were harvested during 29 September to 15 October 2016, 15 January 2017 and 10 August to 20 September 2016, respectively. Higher yield was obtained from turmeric (32.67 t ha^{-1}) followed by elephant foot yam (22.58 t ha^{-1}) and lower from sweet gourd (15.17 t ha^{-1}). In terms of economic return, higher gross return and gross margin was attained from turmeric (561600 Tk. ha^{-1}) in mango based agroforestry system. Mango and Litchi based agroforestry system is getting popularity in different areas of Pabna. Inclusion of turmeric might be a good option for this system in the view of land use improvement and profit. Results from one year study suggest that growing turmeric in mango based agroforestry is promising for higher production and economic return. However, this study needs to conduct another year for comprehensive results.

Weed management in Wheat-Mungbean-Rice cropping pattern under conservation agriculture in High Barind Tract

Conservation agriculture (CA) is based on minimum soil disturbance, permanent soil cover, and crop rotation; it is promoted as a sustainable alternative to systems involving conventional tillage. Adoption of CA changes weed dynamics and communities and therefore necessitates adjusting weed control methods. A field experiment was conducted at Farming System Research and Development (FSRD) site, Kadamshahar, Godagari, Rajshahi during the year of 2015-16 to develop sustainable and effective weed management strategies for wheat-mungbean-T. *Aman* rice under CA system in High Barind Tract. Four weed management strategies such as-WM_1: Pre-plant herbicide (Glyphosate) for wheat+ Pre-plant herbicide (Glyphosate) mungbean+ Pre-emergence: Pretilachlor (Rifit) & Pyrazosulfuron (Logrun) for rice; WM_2: Post emergence: Carfentrazone-ethyle (Affinity) for wheat+ Post emergence: Fenoxaprop-p-ethyl (Whipsuper) for mungbean+ Post-emergence: Pyrazosulfuron (Laser); WM_3: One hand weeding for all crops and WM_4: No weed control were compared for two tillage options ST (strip tillage) and CT (conventional tillage). A split-plot design with three replications was used, with tillage options in the main plots and weed management strategies in the sub-plots. The ST gave higher grain yield of wheat compared to CT. In case of mungbean and T. *Aman* rice ST and CT showed similar grain yields. The weed population and biomass were slightly higher in ST system. Weed management treatment WM_1 recorded the highest yield of all component crops in Wheat-Mungbean-T. *Aman* rice sequence. This treatment also showed minimum weed population and dry weed biomass. Treatment ST with WM_1 showed higher rice equivalent yield, gross margin and BCR.

Response of available soil moisture on the yield of chickpea in High Barind Tract

The experiment was conducted at the FSRD site, Kadamshahar, Godagari, Rajshahi during the year of 2015 -16 and 2016-17 to investigate the effect of available soil moisture on growth and yield of chickpea. Four levels of irrigation were applied for the experiment with four replications. The unit plot size was 6 m × 6 m. The treatments were selected based on irrigation application at different growth stages as T_1= Rainfed, T_2= one irrigation (light irrigation of 1.0-1.5 cm) at post-sowing, T_3= one irrigation (light irrigation of 2-3 cm) at pod development (80-85 DAS) stage and T_4= Two irrigations given each at post-sowing and pod development (80-85 DAS) stages. Seeds were sown on 27 November 2015 and 22 November 2016 at Godagari, Rajshahi at a spacing of 25 cm plant to plant and 40 cm line to line. Soil moisture was measured at every 10 days interval. Measured amount of water was applied to each plot as per treatment to maintain the soil moisture content in the root zone depth up to field capacity. After physiological maturity, pods were harvested from the plants and then dried. After 4-5 days of sun drying, seeds were separated from the pod and again dried for 2-3 days and preserved for future use. The crop was harvested on 9 March 2015-2016 and 20 March 2016-2017. Most of the yield parameters were found higher in treatment T_2 in 2015-2016. T_2 gave the highest seed yield (1.33 t ha^{-1}) in 2015-2016, where one irrigation was applied at post sowing stage while T_3 gave the highest yield (1.43 t ha^{-1}) in 2016-2017, where two irrigations given at post-sowing and pod development stages. Seedling stage and pod development stage were found critical for chickpea. If there is considerable rainfall (that will be helpful for pod development) then one irrigation at post sowing stage (T_2) will be effective for chickpea cultivation. But if there is no rainfall, then one irrigation at pod development stage (T_3) will be needed to produce higher yield.

Response of white grained maize to different levels of irrigation in High Barind Tract

The experiment was conducted at the farmers' field of Godagari, Rajshahi during the rabi season of 2016 -2017 to assess the effect of different levels of water use on the growth and yield of white grained hybrid maize. Five levels of irrigation were applied for the experiment with four replications. Treatments were, T_1= Rainfed, T_2= One irrigation at pre-flowering (55-65) DAS stage, T_3=One irrigation at grain filling (90-100 DAS) stage, T_4= Two irrigations each at pre-flowering (55-65 DAS) and grain filling (90-100 DAS) stages, T_5= Three irrigations each at vegetative (25-30 DAS), pre-flowering and grain filling stages. Recommended dose of fertilizers were applied @ $N_{250}P_{55}K_{110}S_{40}Zn_5B_{1.5}$ kg ha^{-1} and CD @ 5 t/ha. Full doses of P, K, S, Zn, B and cowdung were applied at the time of final land preparation. Nitrogen was applied in equal three splits, 1/3rd amount of urea-N was applied at the time of final land preparation and the rest of the urea-N was applied in equal two installments as top dressing. The experiment was laid out in a RCBD design with three replications. The unit plot size was 5.0 m × 3.6 m. Most of the yield contributing character values found higher in T_5 where three irrigations at vegetative, pre-flowering and grain filling stages were applied that also gave the highest yield (8.48 t ha^{-1}). The lowest yield (6.26 t ha^{-1}) was found in T_1 where no irrigation was applied. The highest benefit cost ratio (BCR) of 2.66 was also achieved with $T_{5.}$ The results indicate that three irrigations might be a good option for higher yield of hybrid maize. On the other hand, it is suggested that in the water stress area like High Barind Tract where irrigation water is not available, two irrigations should be apply for good yield.

Evaluation of management packages against pod borer *(Helicoverpa armigera)* infesting chickpea in High Barind Tract

The study was conducted at FSRD site, Kadamshahar, Godagari, Rajshahi, during Rabi season of 2016-17 to find out an environment friendly management approach for controlling chickpea pod borer at High Barind Tract. There are four treatments viz. T_1: Sex pheromone trap + Spraying of HNPV @ 0.1g/litre of water , T_2: Sex pheromone trap + Spraying of Spinosad (Success 2.5SC) @ 1.2ml/litre of water,T_3:Farmers' practice, Spraying of Chlorantraniliprole + Thiamethoxam (Voliam flexi 300SC) @ 0.5 ml/litre of water and T_4= Untreated control (Water spray only). The experiment was laid out in a Randomized Complete Block Design with three replications. The unit plot size was 20 m x 20 m. The seeds of BARI Chhola-9 were sown on 22 November 2016 in broadcasting methods. Standard agronomic practices were done as recommended. IPM package (T_1) comprising of sex pheromone trapping + Spraying of HNPV @ 0.1g/liter of water showed the best performance as reduced 69.76% pod damage over control and provided significantly the highest yield (1.38 t ha^{-1}). Consequently, the highest benefit cost ratio (2.04) was also recorded from this package. Hence, installation of sex pheromone traps and spraying of HNPV may be recommended for effective management of pod borer in chickpea. Considering seed yield and MBCR, sex pheromone traps and spraying of HNPV may be recommended for effective management of chickpea pod borer.

On farm trial of minor spices in High Barind Tract

An experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Rajshahi during the Rabi season of 2016-17 to select minor spices crop(s) suitable for Barind environments. Five minor spices namely, BARI Methi-1, BARI Mouri-2, BARI Kalojera-1, BARI Dhonia-1 and BARI Dhonia-2 were tested in the farmer's field of HBT. The unit plot size was 10 m × 5 m. The seeds were sown in 30 cm row to row distance and seed to seed 5 cm. Five minor spices namely, BARI Methi-1, BARI Mouri-2, BARI Kalojera-1, BARI Dhonia-1 and BARI Dhonia-2 were tested in the farmer's field of HBT. All the minor spices seeds were sown on 6 December 2016. The seed rate were used 12, 7, 8, 40 and 40 kg/ha for BARI Methi-1, BARI Mouri-2, BARI Kalojera-1, BARI Dhonia-1 and BARI Dhonia-2, respectively. The land was fertilized with 80-35-67 N-P-K kg ha^{-1} for methi, 58-20-38 N-P-K kg/ha for mouri, 58-20-38 N-P-K kg/ha for kalojera, 82-26-50 N-P-K kg/ha for dhonia in the form of urea, triple super phosphate and muriate of potash respectively. Full dose of MoP and TSP and ½ of urea were applied as basal after final land preparation. Another ½ of urea was applied as a top dress at 30 days after sowing. The fungicide Mancozeb @ 2g/L water was used as preventive measures to controlling leaf rotten. The insecticide Tafgor @ 2 ml/L water was applied two times to control incest and pest. One hand weeding was done at 30 DAS. Methi, Kalojera and Dhonia were harvested on 22 March 2017 and Mouri was harvested 15 April 2017. Among the tested spices BARI Mouri-2 gave the highest coriander equivalent yield (1.56 t ha^{-1}), gross return (Tk.218400 ha^{-1}) and gross margin (Tk.183150 ha^{-1}). The lowest coriander equivalent yield (0.89 t ha^{-1}), gross return (Tk.71200 ha^{-1}) and gross margin (Tk.36800 ha^{-1}) was recorded in BARI Dhonia-1. The highest BCR was found from BARI Mouri-2 (6.20) that was significantly higher than all other tested spices. The lowest BCR was found in BARI Dhonia-1 (2.07). All the minor spices crops grew well and produced seed that indicates that these crops are agronomically suitable for HBT. Economic analysis showed that all these spices crops were profitable as produced BCR values more than 2.0. However, BARI Mouri-2 gave higher yield and economic return than all other spices crops. So, BARI Mouri-2 may be recommended for production in the High Barind Tract.

Effect of plant growth regulator on the yield of tomato in High Barind Tract

The experiment was conducted at the farmer`s field of the FSRD site, Kadamshahar, Godagari, Rajshahi during the rabi season of 2016-17 to find out the suitable plant growth regulator (PGR) for higher yield of tomato in High Barind Tract. There were six treatments viz. T_0= Control, T_1= Flora @ 2-3 ml/litre water, T_2= Sadik Bristy @ 1 ml/litre water, T_3= Crop plus @ 1 ml/litre water, T_4= Cheri Gold @ 2 ml/litre water and T_5= Biogreen @ 4 ml/litre water. The experimental design was randomized complete block with 3 replications. Plots were 6 m wide and 10 m long with double row beds with 60 cm inter-row spacing and 50 cm plant spacing to give a density of 4 plants m^{-2}. Twenty five days old seedlings of tomato cv. VL-642 were transplanted by making holes of 5 cm diameter on the film and bare ground on 18 September 2016. All plant growth regulators (PGR) were sprayed in tomato field 4 times. PGR spray was done 7 days interval starting from pre-flowering stage of tomato.The highest no. of fruits $plant^{-1}$ (40.32), unit fruit weight (88.87g), fruit length (8.21cm), fruit breadth (8.78cm), and fruit yield (51.66 t ha^{-1}) were found in T_1 where Flora was used @ 2-3 ml/litre as a PGR followed by T_3 where Crop Plus was used @ 2-3 ml/litre as a PGR. The maximum marginal benefit cost ratio (MBCR) was found in T_1 (9.90) where Flora was used followed by T_3 (9.15) where Crop plus was used.

Effect of planting time on quality seed production of onion in High Barind Tract

A field experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during the Rabi season of 2016-17 to select suitable planting time for onion seed production in High Barind Tract. The experiment was laid out in a randomized complete block design with three replications. The treatments were five planting dates viz. 20 October, 30 October, 10 November, 20 November and 30 November to achieve the objective. The unit plot size was 6 m × 5 m. BARI Piaj-1 was used in the experiment. The bulbs were sown in 50 cm row to row distance and bulbs to bulbs 10 cm. Dates of planting were the treatments of the experiments. The treatments were T_1: 20 October T_2: 30 October, T_3: 10 November T_4: 20 November and T_5: 30 November. The crop was fertilized with recommended doses of fertilizers and manure at the rate of 110-44-125-20 kg N-P-K-S ha^{-1}+ CD 10 t ha^{-1} following FRG, 2012. Onion was harvested on 31 March, 05 April and 12 April 2017, three different dates. The seed yield, yield components and quality of harvested seeds were significantly influenced by different treatments. Among the planting dates, 20 November performed the best followed by 10 November. Thus 10-20 November is the optimum planting time of onion bulb for producing quality seeds.

Performance of mulching and drip irrigation to mitigate soil salinity and conserve soil moisture in tomato field of coastal area

An experiment was conducted at MLT site Kuakata, Patuakhali during the Rabi season of 2016-2017 to investigate the combined effects of drip irrigation and mulches to mitigate soil salinity and improve yield performance of tomato. Four different treatments i.e. T_1: drip irrigation with polythene mulch, T_2: drip irrigation with straw mulch T_3: drip irrigation without mulch T_4: conventional practices were employed in the trial with RCB design. The tomato (cv. BARI Tomato-14) seedlings of 30 days old were transplanted in unit plots of 5 m × 1.2 m with 60 cm × 40 cm spacing on 15 December 2016. For mulching, 10 μm black polyethylene sheet having holes of 50 mm diameter at a distance of 60 cm × 40 cm was spread over the beds and tomato seedlings were transplanted in the holes. For straw mulch, paddy straw at 10 t ha^{-1} was used after transplanting. Recommended fertilizer doses (N_{110}, P_{40}, K_{80} kg ha^{-1}) were used for all treatments except conventional one. Ripened tomato were harvested 6-8 times starting from 12 February to 25 March 2017. The yield and yield-contributing characters in the polythene mulch treatment with drip irrigation were significantly higher compared to those in the un-mulched treatments. The lowest level of salinity and high moisture content was recorded from T_1 in every growth stage of crops ranged from 1.38-3.76 dS/m followed by T_2 (1.36-5.73 dS/m) whereas soil salinity was much higher in the T_3 (1.29-8.46 dS/m) and T_4 (1.32-8.75 dS/m).The yield of mulching treatments were 70.28 t ha^{-1} with polyethylene and 56.23 t ha^{-1} with straw. The lowest yield was obtained from conventional system with no mulch (40.24 t ha^{-1}). The study thus shows that drip irrigation with polythene mulch has an important role to mitigate soil salinity and moisture conservation in tomato field. The highest gross margin Tk. 263360 ha^{-1} was obtained from T_1 although BCR was higher in T_4 treatment. The use of mulch with drip irrigation is a good option not only for water saving and mitigating salinity but also for improving yield. Drip irrigation system with mulching saved 60% of irrigation water and reduced salinity level up to 50% compare to non-mulched control treatment.

Effect of planting system on the performance of lentil and wheat

An experiment was conducted in the farmer's field of Shibpur, Puthia, Rajshahi during rabi 2016-17 to observe the performance of wheat (BARI Gom-26) and lentil (BARI Masur-7) under different seeding options in High Ganges River Floodplain soil. Three seeding options were used in this program. Wheat and lentil exhibited characteristics response toward different seeding options. Among the options, bed planter continuous seeding method and bed planter hill seeding method were superior in respect of yield and economic return. Seed of BARI Gom 26 @ 120 Kg ha^{-1} was sown on 23 November 2016. Crop was harvested on 15 March 2016. BARI Masur-7 and BARI Gom-26 were used as variety. The unit plot size was 8m × 5m. The land was fertilized with 24-18-20 N-P-K kg ha^{-1} (FRG, 2005) in the form of urea, triple super phosphate and muriate of potash, respectively. All fertilizers were applied as basal after final land preparation. Different management practices like weeding, irrigation and harvesting were done for normal growth of the crop. The crop was sown on 23

November 2016 and was harvested on 12 March 2016. The highest wheat seed yield (4.26 t ha^{-1}) and gross margin (Tk. 70700 t ha^{-1}) was obtained in T_2 (bed planting with continuous seeding) which was similar to T_1 (bed planting with hill seeding). Similar trend was also found in lentil. The highest lentil seed yield (1.81 t ha^{-1}) and gross margin (Tk. 121740 t ha^{-1}) was obtained in T_2 (bed planting with continuous seeding) which was similar in T_1 (bed planting with hill seeding).

Effect of spacing on the yield of *Hypnea musciformis*

The experiment was conducted during winter season at Nunierchara sea beach to test the effect of spacing on the yield of *Hypnea musciformis*. Four treatments were considered. The treatments were 10 cm, 20 cm, 30 cm and 40 cm spacing. The seeds were sown on 27 December, 2016 and harvested on 27 January, 2017. The experiment was conducted Nuniarchara, Cox's Bazar. An area of 10 (ten) acre of sea beach was leased from a farmer and experiments was set during December, 2016 using only "one-step" "seed" production method which require healthy seaweeds. Four treatments were considered. The treatments were 10 cm, 20 cm, 30 cm and 40 cm spacing. The seeds were sown on 27 December, 2016 and harvested on 27 January, 2017. Seeds for seaweed farming was produced by "one-step" (directly using cut pieces and tied with the ropes) methods (Redmond et al. 2014). Healthy seaweeds collected from the SMI was cut into pieces and cut pieces ("seeds") were inserted quickly at 10 to 40 cm gap into the 15-25 m long, 1.0 to 1.5 cm diameter synthetic ropes/strings. The ropes was transferred immediately to the open sea. The depth at which the ropes was set depends on the species, light, temperature and turbidity of the seawater. In turbid water during spring season ropes was set at 0.6 m depth where about 318 µE m^{-2} s^{-1} Photosynthetically Active Radiation (PAR) was available, the intensity at which most of the seaweeds grow in the SMI. The highest yield 3572.04 gm m^{-2} was obtained from 20 cm spacing while 40 cm spacing gave the lowest yield 2162.65 gm m^{-2}.

Performance of seaweed species in open sea

The experiment was conducted during winter season at Nunierchara sea beach to find out the suitable seaweed species. Eight species (two from green, 3 from red and 3 from browns) was considered suitable in the adaptive trial research. The selection of eight species was done according to the serial of species from each group. During February 2017, 8 (Eight) species were collected from SMI and plants was taken into tanks separately with seawater having a temperature of about 15-20º C (putting ice), transported to the project site by speed boat. Healthy seaweeds was cut into pieces and cut pieces ("seeds") were inserted quickly at 10 to 15 cm gap into the 15-25 m long, 1.0 to 1.5 cm diameter synthetic ropes/strings. The ropes was transferred immediately to the open sea. The depth at which the ropes was set depends on the species, light, temperature and turbidity of the seawater. In turbid water during spring season ropes was set at 0.6 m depth where about 318 µE m^{-2} s^{-1}. The whole processes was completed by 8 to 12 hours. After 30 days of transplanting only Hypnea survived. Other seaweeds were not survived due to high turbidity and high wave.

Project III: On-farm Trials with Advanced lines and Technologies

On-farm trial of BARI released wheat varieties

An experiment was conducted at the farmer's field of Faridpur, Dinajpur, Khulna, Bandarban, Bhola, Bogra and Noakhali to evaluate the performance of different BARI released latest wheat varieties under different AEZ's and to popularize them among the farmers to promote their adoptions. This experiment was executed during 2015-16 and 2016-17 in Faridpur, Dinajpur and Khulna whereas for other locations, it was only during 2016-17. It was laid out in RCB design with three to six replications. A total number of six varieties viz., BARI Gom-25, BARI Gom-26, BARI Gom-27, BARI Gom-28, BARI Gom-29 and BARI Gom-30 were tested in Faridpur, Dinajpur, Noakhali and Khulna. In other locations except Bogra, trial was conducted excluding one to two variety. In Bogra, one check variety (BARI Gom-24) was included along with other six varieties. The crop was sown from 18 November to 17 December 2016 in different locations and was harvested from 14-30 March

2017 in this year. In Faridpur and Kushtia, the highest grain yield was obtained from BARI Gom-30 (3.56 t ha^{-1}) and BARI Gom-28 (3.98 t ha^{-1}), respectively whereas the lowest grain yield was found from BARI Gom-27 (3.24 to 3.34 t ha^{-1}). BARI Gom-30 gave the highest grain yield in Bogra (4.12 t ha^{-1}) and Bandarban (3.05 t ha^{-1}). In Bhola, the highest grain yield was found from BARI Gom-28 (4.04 t ha^{-1}). BARI Gom-26 gave the highest seed yield in Dinajpur (4.36 t ha^{-1}). In saline area of Khulna, BARI Gom-25 performed satisfactorily (2.00 t ha^{-1}). In saline area of Noakhali, the highest grain yield was observed in BARI Gom- 29 (2.52 t ha^{-1}) followed by BARI Gom- 25 (2.16 t ha^{-1}) and BARI Gom- 26 (2.14 t ha^{-1}). The yields of wheat varieties in those locations were lower in comparison to their yield potentiality might be adverse effect of salinity during reproductive stage. The highest gross return was found from the variety where the highest grain yield was obtained.

Pest incidence: In Bogra, Leaf blight was observed in some plots. The disease was controlled by spraying of Rovral @ 2 g/L. For preventing blast disease, Nativo @ 6g/10L was applied twice at panicle initiation stage and 15 days after first spray. In Noakhali, Tilt 250 EC @ 2ml/5L were applied twice with an interval 7 days.

On-farm trial of BARI hybrid maize varieties

The trial was conducted at the farmer's field of Tangail and Bandarban during Rabi 2016-17 to compare the performance of BARI developed hybrid maize varieties with locally available commercial maize varieties. At Tangail, the trial was conducted with BARI Hybrid Bhutta-7, BARI Hybrid Bhutta-9 and a promising hybrid line P_1XP_7 over locally available hybrid maize variety. At Bandarban, BARI Hybrid Bhutta-5, BARI Hybrid Bhutta-7, BARI Hybrid Bhutta-9 were tested with NK-40 as a check variety. BARI Hybrid Bhutta-9 produced the highest grain yield 10.30 t ha^{-1} and 8.69 t ha^{-1} respectively at Bhuapur and Mirzapur, Tangail. In the hill valley of Bandarban NK-40 (9.61 t ha^{-1}) out yielded BARI Hybrid Bhutta-9 (9.28 t ha^{-1}).

Adaptive trials with BARI barley varieties in southern belt and Barind Tract

The trial was conducted at the farmer's field of Barind, Rajshahi and Noakhali during Rabi 2016-17 with a view to select high yielding barley varieties/advance lines for drought and saline area areas. Two barley varieties namely BARI Barley-5, BARI Barley- 6 and three advance lines viz. BHL-19, BHL-25 and BHL-26 were selected for drought areas and five varieties viz. BARI Barley-1, BARI Barley-2, BARI Barley-3, BARI Barley-4, BARI Barley-5, BARI Barley-6 and BARI Barley-7 were evaluated in saline areas. Among the tested varieties/lines, BHL-19 (2.19 t ha^{-1}) and BARI Barley-6 (2.08 t ha^{-1}) produced maximum grain yield in drought areas and BARI Barley-5 (2.13 t ha^{-1}) performed better in saline areas.

On-farm trial of BARI foxtail millet varieties in hilly areas

The trial was conducted at Kyamlong para hill valleys in Bandarban during the Rabi season of 2016-17 to compare the performance of BARI developed foxtail millet varieties. Three varieties viz. BARI Kaon-1, BARI Kaon-2 and BARI Kaon-3 were evaluated in the experiment. Among the three varieties, BARI Kaon-2 gave the highest yield (1.86 t ha^{-1}) followed by BARI Kaon-1 (1.75 t ha^{-1}). BARI Kaon-3 gave the lowest yield (1.72 t ha^{-1}).

Adaptive trial of short duration mustard varieties in farmers' field

The experiment was conducted at the farmer's field of Kushtia, Kishoreganj, Dinajpur and Noakhali during Rabi season of 2016-17 to evaluate the yield performance of newly released high yielding mustard varieties and to popularize and disseminate them in the farmer's field. The varieties were BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17 were tested at Kushtia, Kishoreganj, and Dinajpur, while at Noakhali BARI Sarisha-11, BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17 and Tori-7 were tested. BARI Sarisha-17 produced the highest yield at Kishoreganj (1.64 t ha^{-1}), Kustia (1.55 t ha^{-1}) and Dinajpur (1.49 t ha^{-1}) while all the four varieties namely BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17 gave similar seed yield ranging from 1.21 to 1.39 t ha^{-1}. The Tori-7 recorded the lowest seed yield in all the locations.

Adaptive trial of advanced lines of rapeseed

A field trial was carried out at the FSRD site Pushpapara Pabna and MLT site, Purbadhala Netrakona and Kasbha, Brahmanbaria during Rabi season of 2016-17 to evaluate the comparative performance of rapeseed genotypes. The trial consisted of four advanced lines viz. BC-2010-01, BC-2010-02, BC-0828-01, BC-0832-02 along with two varieties as check viz. BARI Sarisha-14 and Tori-7. The yield performance of BARI Sarish-14 and four advanced lines BC-2010-01, BC-2010-02, BC-0828-02 and BC-0832-02 appeared to be promising in the tested location as compared to Tori-7. Among the tested lines/varieties, statistically similar grain yield was obtained from BC-2010-01 (1.75 t ha^{-1}), BC-2010-02 (1.55 t ha^{-1}), BC-0828-02 (1.57 t ha^{-1}), BC-0832-02 (1.77 t ha^{-1}) and BARI Sarisha 14 (1.70 t ha^{-1}) and the lowest from Tori-7 (1.21 t ha^{-1}) in Pabna. Among the advanced line, BC-0828-2(1) produces the highest seed yield compared to other lines and check variety in Brahmanbaria. The highest seed yield was obtained from BARI Sarisha-14 (1.40 t ha^{-1}) followed by BC-2010-01 (1.28 ha^{-1}), BC-2010-02 (1.27 t ha^{-1}), BC-0828-02 (1.04 t ha^{-1}) and BC-0832-02 (1.03 t ha^{-}1) at Purbadhala, Netrakona.

Adaptive trial of different sunflower varieties

An experiment was conducted at MLT site Kuakata, Patuakhali during the Rabi season, 2016-17 to evaluate the performance of sunflower varieties in coastal environment under farmers field condition. Three sunflower varieties BARI Surjamukhi-2, Hysan-33 and Hybrid (syngenta) were evaluated. Statistically significant difference was found in grains/head, 1000-grain weight and grain yield. The highest yield was observed from the Hysan-33 (2.54 t ha^{-1}) and the lowest yield was obtained from the BARI Surjomukhi-2 (2.12 t ha^{-1}). The Gross margin (Tk.46820) and BCR (1.85) was also higher in Hysun-33. BARI Surjomukhi-2 is earlier but height is not uniform.

On-farm trial of soybean varieties under rainfed condition

An experiment was conducted at the farmers' field of FSRD site Jalalpur, Sylhet and MLT site, Daulatkhan, Bhola district during the Rabi season of 2016-17 to evaluate the performance and popularize the newly developed soybean varieties among the farmers of those locations. BARI Soybean-5 and BARI Soybean-6 were tested against check variety Shohag in Sylhet under rainfed condition while, BARI and BINA developed soybean varieties viz. BARI Soybean-5, BARI Soybean-6, Binasoybean-1, and Binasoybean-2 were tested in Bhola district. The soyabean varieties were grown in randomized complete block design with six dispersed replications. Among the tested varieties, BARI Soybean-6 gave the highest seed yield in both locations. Yield of all varieties were also satisfactory except shohag. The maximum economic return was obtained by BARI Soybean-6.

Peat incidence: Only leaf feeding caterpillar infestation was observed. Volume Flexi was sprayed twice at an interval of 10 days to control it.

Adaptive trial of advanced lines of sesame

An adaptive trial was conducted at the farmer's field of Kumarkhali, Kushtia during 2016-17 to evaluate the performance of advanced lines of sesame in Kushtia region. Four advanced lines Ses-9751, Ses-9768, Ses-05163, Ses-2010-01R and BARI Til-4 (check) was tested in the study. Out of the tested lines, Ses-9751 offered the highest yield which was statistically similar with all tested varieties/lines except Ses-2010-01R. Very poor germination was observed in Ses-2010-01R and seeds of Bina til-1 failed to germinate. Farmers preferred white colored advance line Ses-05163 due to higher yield and market demand.

Adaptive trial of sesame varieties in the charland of munshiganj

The experiment was conducted in the farmers' field at MLT site, Munshiganj during 2015-16 and 2016-17 cropping season to evaluate the performance of BARI Til-4 in potato based cropping pattern for increasing the cropping intensity and productivity. Two varieties of sesame viz. BARI Til-4 and a local variety were included in the study. The mean yield of last two years revealed that BARI Til-4 produced higher seed yield (1331.00 kg ha^{-1}) than that of local variety (1253.00 kg ha^{-1}). Higher gross margin was also obtained from BARI Til-4 (Tk. 7210.00 ha^{-1}) compare to that of local variety (Tk. 6355.00 ha^{-1}).

On-farm trial of BARI developed groundnut varieties in haor and charland areas

The experiment was conducted at Sylhet and Cimilla district during Rabi season of 2016-2017 to evaluate the performance of groundnut varieties in haor and Charland areas of Sylhet and Comilla. At Comilla, four improved varieties of groundnut viz. BARI Chinabadam-9, BARI Chinabadam-10, Bina Chinabadam-4, Bina Chinabadam-8 and a local variety but at Sylhet two improve varieties viz. BARI Chinabadam-8 and BARI Chinabadam-9 including a local variety were used in the experiment. At Sylhet, the highest pod yield was recorded in BARI Chinabadam-9 (1.57 t ha^{-1}) and the lowest in local variety (1.25 t ha^{-1}). At Comilla, BARI Chinabadam-10 produced the highest pod yield (3.4 t ha^{-1}) and lowest yield (1.9 t ha^{-1}) was obtained from the local Dhaka-1 variety. In both locations, higher gross margin provided by BARI groundnut varieties and lowest from the local varieties.

Adaptive trial of blackgram genotypes in High Barind Tract

The field trial was carried out at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during *Kharif*-2 season 2016 to evaluate the high yielding blackgram genotypes in drought prone area. Six genotypes/varieties of blackgram viz. BBLX-08010-2-1, BBLX-08010-4-1, BBLX-02005-1, BBLX-07002-5, BBLX-07002-1 and BARI Mash-3 were tested in the farmer's field. Among the tested genotypes/varieties BBLX-02005-1 gave the maximum seed yield (1.39 t ha^{-1}) followed by BARI Mash-3 (1.30 t ha^{-1}). The BBLX-07002-1 gave minimum seed yield (1.17 t ha^{-1}).

Performance of blackgram varieties

A field trial was conducted at the MLT site, Joypurhat, Bogra during Kharif, 2016-17 to evaluate the performance of modern blackgram varieties under farmers' field condition. Four varieties of blackgram viz. BARI Mash-1, BARI Mash-2, BARI Mash-3 and Local (check) were tested in the study. Seeds were sown on 3-7 September 2016. The crop was harvested during 7-9 December 2016. Out of the tested varieties, BARI Mash-3 gave the highest yield followed by BARI Mash-1 and BARI Mash-2. Hairy caterpillar was observed in some plots. The pest was controlled by destroying early instar larvae with handpicking and Karate@ 1 ml/Lwas sprayed in the field. Farmers are interested to grow BARI Mash-3 for its higher yield.

Adaptive trial of lentil varieties in farmers' field

An adaptive trial was conducted at Kushtia during 2016-2017and Khulna during 2014-15, 2015-16 and 2016-17 to observe the performance of newly developed lentil varieties under farmer's field condition. BARI developed three lentil varieties viz. BARI Masur-6, BARI Masur-7 and BARI Masur-8 were tested at Kushtia and seven lentil varieties viz. BARI Masur-4, BARI Masur-5, BARI Masur-6, BARI Masur-7, BARI Masur-8, Binalentil-5, Binalentil-6 and one local variety were tested in order to select suitable lentil variety for the coastal region of Khulna. At Kushtia, BARI Masur-8 offered the highest seed yield and return followed by BARI Masur-7. At Khulna, BARI Masur-6 produced the highest seed yield 2.03 t ha^{-1} and 0.94 t ha^{-1}during 2014-15 and 2015-'16 , respectively. In 2016-'17 the highest yield (1.88 t ha^{-1}) obtained from BARI Masur-8 while the lowest yield from the local variety 1.58 t ha^{-1}, 0.84 and 1.07 t ha^{-1}, respectively.

On farm trial of chickpea at High Barind Tract

A field experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Rajshahi during Rabi 2016-17 to select suitable variety through on farm trial under Barind environment. Four advanced varieties/genotypes of chickpea namely, BARI Chola-5, ICCV-92944, ICCV-93954 and BARI Chola-9 were tested in the farmer's field of HBT. Among the tested entries BARI Chola-9 gave the highest seed yield (1.26 t ha^{-1}) that was followed by ICCV-92944 (1.25 t ha^{-1}). The insecticide *Karate* @ 2 ml/L water was applied two times to control pod borer. Farmers chose variety BARI Chola-9 and the genotype ICCV-92944, due to higher yield.

Participatory varietal selection of blackgram

The field trial was carried out at the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during Kharif-2 season 2016 to select suitable variety through participatory varietal selection under drought prone area. Four genotypes/varieties of blackgram viz. BBLX-06002-10, BBLX-07002-5, 86337 and BARI Mash-3 were tested in the farmer's field. Among the tested genotypes/varieties BBLX-07002-5 gave the highest seed yield (1.38 t ha^{-1}) followed by BARI Mash-3 (1.30 t ha^{-1}) and the 86337 gave lowest seed yield (1.14 t ha^{-1}).

Participatory varietal selection of chickpea in HBT

A field trial was conducted in the farmer's field of FSRD site, Kadamshahar, Godagari, Rajshahi during Rabi 2016-17 to develop variety through farmer's selection under Barind environment. Two advanced lines of chickpea viz. BCX-08009-9, BCX-08001-3 and two varieties BARI Chola-5 and BARI Chola-9 were tested in the farmer's field. Among the tested entries the BCX-08009-9 (1.34 tha^{-1}) and variety BARI Chola- 9 (1.29 t ha^{-1}) gave the maximum and similar seed yield. The BCX-08001-3 gave minimum yield (0.82 tha^{-1}).

Regional yield trial of chickpea in High Barind Tract

A field experiment was conducted in the farmer's field of FSRD site, Kadamshahar, Rajshahi during Rabi 2016-17 to select suitable variety through regional yield trial under Barind environment. Eight advanced varieties/lines of chickpea namely, BARI Chola-5, ICCV-93954, BCX-09010-9, BCX-09010-2, ICCV-07102, ICCV-12115, ICCV-12110 and BARI Chola- 9 were tested in the farmer's field of HBT. Among the tested entries BCX-09010-2 and ICCV-12110 were taken the maximum and minimum days for flowering, respectively and on the other hand, ICCV-12115 and BARI Chola-5 were taken the maximum and minimum days for maturity, respectively. The ICCV-12110 gave the highest seed yield (1.55 t ha^{-1}) followed by BARI Chola- 9 (1.33 t ha^{-1}). The lowest yield (1.01 t ha^{-1}) was obtained from BCX-09010-2.

Pod borer is the main threat of chickpea cultivation. The insecticide *Karate* (Lamda Cyhalothrine) @ 1 ml L^{-1} water was applied two times to control pod borer viz. at flowering and pod setting stage. Among the tested genotypes, BARI Chola-9 and ICCV-12110 performed better.

Adaptive trial with newly released potato varieties

The trial was conducted at farmers' field of Kushtia, Comilla, Satkhira, Rajshahi, Mymensingh Tangail, Patuakhali, Rangpur, Gupalganj and Dinajpur during Rabi season of 2016-17 to evaluate the performance of tuber yield of selected potato varieties/lines and also to know farmers' opinion about the varieties. Potato varieties viz. BARI Alu-7, BARI Alu-8, BARI Alu-13 (Granola), BARI Alu-25, BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-40, BARI Alu-41, BARI Alu-46 and BARI Alu-53 were tested in different locations. Among the tested potato varieties BARI Alu-37, BARI Alu-40, BARI Alu-41(5.183), BARI Alu-46 and BARI Alu-53 performed better in most of the locations. Scab infestation was observed at most of the locations and its severity was high with variety Diamant. Late blight disease was observed in some locations. Farmers' choice of potato variety varied with locations mostly for yield performance and skin colour. According to farmers' choice the popular variety Diamant could be replaced with BARI Alu- 40, BARI Alu- 41, BARI Alu-46, and BARI Alu-53 on the basis of yield and disease infestation.

On-farm trial of newly released BARI sweet potato varieties

The on-farm trials were conducted at Comilla, Narsingdi, Kishoreganj and Sylhet during Rabi season of 2016-17 to evaluate the performance of BARI released sweet potato varieties. Six sweet potato varieties viz. BARI SP-4, BARI SP-5, BARI SP-8, BARI SP-11, BARI SP-12, BARI SP-13 and a local variety were tested. The experiment was laid out in RCB design with six dispersed replications. BARI Mistialu-12 produced higher yield at Kishoreganj (45.16 tha^{-1}) and Narsingdi (41.35 t ha^{-1}). At Sylhet, the highest yield was obtained from BARI Misti alu-13 (42.67 t ha^{-1}) whereas local variety (22.75 t ha^{-1}) gave higher yield in the farmers' field of Comilla.

Adaptive trial of BARI released panikachu varieties

The on-farm trial was conducted on six farmers' field at Comilla and Sherpur to observe the performance of BARI released panikachu varieties with the local cultivar. Four BARI panikachu varieties viz., BARI Panikachu-1, BARI Panikachu-2, BARI Panikachu-3, BARI Panikachu-5 and a local variety as check were used for the trial. At Comilla, BARI Panikachu-3 gave the highest stolon yield (14.63 t ha^{-1}), petiole yield (9.53 t ha^{-1}), rhizome yield (65.59 t ha^{-1}) as well as total yield (89.75 t ha^{-1}) followed by BARI Panikachu-5 (69.57 t ha^{-1}). At Sherpur, the highest rhizome yield (30.62 t ha^{-1}) was recorded from BARI Panikachu-5 but the highest stolon yield (20.53 t ha^{-1}) was obtained from BARI Panikachu-2. In both locations, local variety produced the lowest rhizome and stolon yield. To control the insect disease and red mite spraying Admire @ 1 ml L^{-1}, Abon 1.8 EC @ 1 ml L^{-1} Karate 2 ml L^{-1}and Ridomil gold @ 5 g L^{-1} of water were applied in Comilla.

Adaptive trial with improved lines and varieties of panikachu

The trial was executed at the farmers' field of Matiara village under the MLT site of Barura upazila under Comilla district to test the adaptability of the promising lines and improved varieties of Panikachu. Three panikachu lines e.g. PK-109, PK-119 and PK-134 and three panikachu varieties namely BARI Panikachu-1, BARI Panikachu-2 and local variety (Potivawal) were tested. BARI Panikachu-1 gave the highest stolon yield (21.95 t ha^{-1}) than all other varieties and lines while the lowest was in PK-134 (8.04 t ha^{-1}). BARI Panikachu-2 produced maximum rhizome yield (18.94 t ha^{-1}) over all other varieties including local check.

Adaptive trials with improved varieties of mukhikachu

An experiment was carried out at Comilla and Rangpur during Kharif season of 2016 and at Sherpur and Rangpur during 2015 and 2016 to evaluate the yield performance of BARI Mukhikachu-1 and BARI Mukhikachu-2 with local variety at farmer's field condition. BARI Mukhikachu-1 with local variety was used at Rangpur. BARI Mukhikachu-2 and a local variety was used at Comilla. Mukhikachu-2 produced higher yield both at Comilla (32.52 t ha^{-1}) and Sherpur (27.81 t ha^{-1}) whereas BARI Mukhikachu-1(26.09 t ha^{-1}) produced higher yield at Rangpur. In all the locations, local variety produced lower yield.

On-farm trial of BARI developed winter tomato varieties

The trail was conducted at Comilla, Satkhira and Khulna, Shyampur, Sylhet, Pabna, Patuakhali and Noakhali during Rabi season of 2016-17 to evaluate the performance of BARI developed tomato varieties at different locations of the country. Two varieties viz., BARI Tomato-14, BARI Tomato-15 along with Local (Check) were evaluated in the study. Higher yield of BARI Tomato-14 was found in Patuakhali (81.0 t ha^{-1}), Noakhali (81.0 t ha^{-1}), Shyampur, Rajshahi (87.8 t ha^{-1}), Satkhira (73.2 t ha^{-1}), Pabna (59.1 t ha^{-1}) and Sylhet (52.2 t ha^{-1}). At Comilla, BARI Tomato-15 (79.1 t ha^{-1}) performed better over BARI Tomato-14 (78.8 t ha^{-1}).

On-farm trial of BARI developed summer hybrid tomato variety

An on-farm trial was conducted at Narsingdi, Rajshahi, Comilla and Noakhali during Kharif, 2016 to evaluate the performance of BARI developed summer hybrid tomato in farmers' field. Two BARI developed summer hybrid varieties viz. BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 were evaluated in the study. BARI Hybrid Tomato-4 performed better in Comilla (18.38 t ha^{-1}) whereas BARI Hybrid Tomato-8 produced higher yield in Noakhali (72.51 t ha^{-1}), Rajshahi (27.16 t ha^{-1}) and Narsingdi (19.89 t ha^{-1}).

On-farm trial of BARI country bean variety

The experiment was conducted at Sylhet, Khulna, Tangail and Noakhali during Rabi season of 2016-17 to evaluate the performance of BARI developed country bean variety BARI Shim-6 along with local variety under farmer's field condition. BARI Shim-6 produced higher pod yield compared to local variety in all locations except Sylhet where local variety (12.75 t ha^{-1}) produced higher yield than BARI shim-6 (11.96 t ha^{-1}). The yield of BARI Shim-1 was the highest at Khulna (19.67 t ha^{-1}). At Tangail (14.44 t ha^{-1}) and Noakhali (14.37 t ha^{-1}) yield was almost similar.

On-farm trial of bari developed summer hyacinth bean variety

An experiment was conducted at the farmers' field of Sylhet and Comilla district during the Kharif-I season of 2016 to evaluate the performance of BARI Shim-7 against local variety in summer season. Two varieties of summer hyacinth bean viz., BARI Shim-7 and local cultivar was used as check. At Sylhet, BARI Shim-7 produced higher pod yield (6.20 t ha^{-1}) than local cultivar Patashim (3.68 tha^{-1}) with gross margin (Tk. 81700 ha^{-1}). At Comilla, BARI Shim-7 produced higher flower and pods in summer season and produced huge marketable yield (13.52 t ha^{-1}) along with higher gross margin (Tk. 189900.00ha^{-1}) but local variety produced vigorous vegetative growth without flowering and bearing.

Sylhet: Yellow mosaic virus was infested in some plants at later stage but it was less in Patashim. Aphid infestation was severe in both the varieties. Pod borer insect was also recorded but it was not so severe. Insecticide, Success @ 0.40 ml L-1 of water was applied for effective control of pod borer.

On-farm trial of BARI developed bottle gourd variety for summer season

The trial was conducted at Narsingdi and Noakhali during Kharif season of 2016 to evaluate the performance of BARI developed high yielding summer bottle gourd variety in the farmer's field. BARI Lau-4 and local (check) were used in this study. BARI Lau-4 (46.36 t ha^{-1}) gave higher yield compare

Screening of eggplant varieties against salinity

The experiment was conducted at MLT site, Kuakata, Patuakhali during Rabi season of 2016-2017. Ten BARI developed egg plant varieties (BARI Begun-1, BARI Begun-6, BARI Begun-7, BARI Begun-8, BARI Begun-9, BARI Hybrid Begun-3, BARI Hybrid Begun-4, BARI Bt Brinjal-1, BARI Bt Brinjal-2 and BARI Bt Brinjal-4) were planted to evaluate their performance in saline area. Egg plant var. BARI Bt Begun-1 produced the highest fruit yield (21.70 t ha^{-1}) which was statistically identical to followed by BARI Begun-6 (19.53 t ha^{-1}). BARI Begun-8 gave the lowest yield (9.17 t ha^{-1}). However, it is the result of 1st year trial should be continued for the next year for concrete result.

On-farm trial of BARI developed ridge gourd variety

A field trial was conducted at Mymensingh during Kharif season of 2016 to evaluate the performance of BARI Jhinga-1 with a local cultivar. Local cultivar (hybrid) produced 18 % higher yield (15.53 t ha^{-1}) than BARI Jhinga-1(13.12 t ha^{-1}).

Pest and disease incidence: Fruit fly, red pumpkin beetle and epilachna beetle etc. were observed in some plots. These pests were controlled by spraying of Sevin 2 g L^{-1} water. Fruit fly was controlled by using sex pheromone trap. Sporadically the crop infested by downy mildew and it was controlled by spraying Thiovit @ 2g L^{-1} water at 10 days interval.

Farmers are interested to cultivate BARI Jhinga-1 in future.

Adaptive trial of BARI developed boroccoli variety

The experiment was conducted at farmers' field of Comilla, Pabna, Mymensingh, Patuakhali, Noakhali and Rangpur district during the Rabi season of 2016-17 to evaluate the performance of BARI Broccoli-1 against locally cultivated hybrid variety. The yield potentiality of the BARI Broccoli-1 was higher in Comilla (24.68 t ha^{-1}) and Mymensingh (17.56 t ha^{-1}). But Local hybrid variety yielded more at Pabna (19.16 t ha^{-1}), Mymensingh (19.68 t ha^{-1}), Comilla (18.41 t ha^{-1}), Noakhali (13.67 t ha^{-1}) and Rangpur (24.16 tha^{-1}) over BARI Broccoli-1.

On-farm trial of BARI developed sweet gourd varieties

An on-farm trial was conducted at Satkhira, Comilla and Mymensingh during Rabi season of 2016-17 to evaluate the performance BARI developed high yielding sweet gourd varieties. At Satkhira, BARI Hybrid Mistikumra-1 was tested against BARI Mistikumra-1. At Comilla, BARI Hybrid Mistikumra-1 against Hybrid Mistikumra (Swity) and at Mymensingh, BARI Mistikumra-1, BARI Hybrid Mistikumra-1 and a local cultivar were used. BARI Hybrid Mistikumra-1 produced higher yield 38.68 t ha^{-1}, 42.37 t ha^{-1} and 34.00 t ha^{-1} and gross margin Tk. 125450.00 ha^{-1}, Tk.263160.00 ha^{-1} and Tk.269800 ha^{-1} at Satkhira, Comilla and Mymensingh, respectively.

On farm adaptive trail of BARI developed okra variety

The on-farm trial was conducted at the farmers' field of Comilla and Mymensingh district during Kharif season of 2016 to evaluate the performance of BARI Dherosh-2 against a local variety Shanti at Comilla and Krishan Moni at Mymensingh as check. At Comilla and at Mymensingh, BARI Dhesosh-2 produced 9.77 and 15.38 t ha^{-1} whereas local variety 7.35 and 13.56 t ha^{-1}. The highest gross margin was recorded in BARI Dherosh-2 and the lowest in local varieties. BARI Dherosh-2 was found resistant to YMV in the farmers' field compared to the local variety

Performance of BARI released pointed gourd varieties

A field trial was conducted at the MLT site, Joypurhat during Rabi, 2015-16 to evaluate the performance of pointed gourd varieties under farmers' field condition in level Barind tract. Three-pointed gourd varieties viz. BARI Potol-1, BARI Potol-2 and Local (check) variety were evaluated in the study. The highest yield was obtained from BARI Potol-1 (27.58 t ha^{-1}).

Leaf blight was observed in some plots. The disease was controlled by spraying of Tilt @ 0.5ml L^{-1}. Farmers are showing interest to grow BARI Potal-1 due to its higher yield as well as economic return.

Performance of BARI garden pea varieties

The experiment was conducted at Daulatkhan and Sadar, Bhola under AEZ-18 in Rabi season 2015-16 and 2016-17. Agronomic performance of BARI Motorshuti-1 and BARI Motorshuti-3 were tested under farmers' field condition to select suitable garden pea variety(s) for Bhola region. BARI Motorshuti-1 (7.40 t ha^{-1}) produced higher green pod yield than BARI Motorshuti-3 (6.15 t ha^{-1}).

On-farm trial of BARI developed spinach varieties

An experiment was conducted at the farmers' field of Comilla, Pabna, Mymensingh, Patuakhali and Noakhali district during the Rabi season of 2016-17 to evaluate the performance of BARI Palongsak-1 among the farmers. BARI Palongsak-1 and a local variety were included as check in the experiment. Spinach var. BARI Palongsak-1 produced the higher yield than local variety at Comilla (14.56 t ha^{-1}), Pabna (14.39 t ha^{-1}), Mymensingh (19.35 t ha^{-1}), Noakhali (22.83 t ha^{-1}) and Patuakhali (14.80 t ha^{-1}). The highest gross margin were recorded from BARI Palongsak-1 due to higher yield than the local variety.

On-farm trial of different gladiolus genotypes in coastal area

An experiment was conducted at MLT site Amtali, Barguna and MLT site Bauphal, Patuakhali during Rabi 2016-2017 to introduce and popularize gladiolus production in farmers field. Four different gladiolus genotypes viz. white colour, yellow colour, purple colour and red colour were tested. The spike yield of all the genotypes were identical but the market value of white & purple coloured genotypes were higher (Tk.6 spike^{-1}) than other two genotypes like yellow & red (Tk.5 spike^{-1}). The highest gross return (Tk.1110000 ha^{-1}) as well as gross margin (Tk.615000 ha^{-1}) was also recorded from white & purple genotypes.

Effect of irrigation on yield of onion at farmer's field

An experiment was conducted at the FSRD Site, Hatgobindapur, Faridpur under the AEZ 12 during the Rabi 2016-17 to find out aoptimum irrigation frequency for potential yield of winter onion. There were four irrigations treatments, which were applied at different growth stages of onion i..e. 2-irrigations each at just after planting and 25 DAT (I_2 orFarmer`s practice), 3-irrigations each at just after planting and 25 and 45 DAT (I_3), 4-irrigations each at just after planting and 25,45 and 65 DAT (I_4), 5-irrigations each at just after planting and 25,45,65 and 85 DAT(I_5) were placed in the sub plot and two onion varieties; i.e. BARI Piaz-1 (V_1) and BARI Piaz-4 (V_2) were placed in the main plot. The experiment was laid out in split plot design with three replications. Interction effect of variety and irrigation treatments were significant. BARI Piaz-4(V_2) produced the highest bulb yield (16.19 tha^{-1}) in combination with five irrigations (I_5) which was statistically identical to V_2I_3 and V_2I_4. The highest gross margin (Tk. 126490 ha^{-1} and Tk. 121970 ha^{-1}) and the highest benefit cost and ration (2.30 and 2.90) were obtained from the treatments V_1I_3 and V_1I_5, respectively.

On farm trial of garlic varieties

An experiment was conducted at Faridpur during three consecutive cropping year 2014-15, 2015-16 and 2016-17 and at Bogra during Rabi season of 2016-17 to evaluate the performance of BARI released garlic varieties under farmer's field condition. The experiment was laid out in RCB design replicating in six farmers' fields. Garlic varieties viz., BARI Rashun-1 and BARI Rashun-2 were tested against local variety as check. At Faridpur, the highest bulb yield (7.11 tha^{-1}) was obtained from BARI Rashun-2 followed by BARI Rashun-1 (5.72 t ha $^{-1}$). BARI Rashun-2 provided 37% higher yield over local variety (5.20 t ha^{-1}). BARI Roshun-2 (8.19 t ha-^{1}) gave 46% higher marketable yield than local variety. The highest gross margin was also obtained from BARI Rashun-2 due to higher bulb yield at both the locations.

On-farm verification trial of coriander at char land

An experiment was conducted at the char land of Debdhunga, Sariakandi, Bogra during Rabi season of 2016-17 to evaluate the performance of BARI Dhonia-1and BARI Dhonia-2 under farmer's field condition and to popularize among the farmers. BARI Dhania-2 (1.16 t ha^{-1}) performed better over the local check variety (0.95 t ha^{-1}).

On-farm verification trial of black cumin at charland

An on-farm trial was conducted at Bogra and Faridpur during the Rabi season of 2016-17 to evaluate the performance of black cumin variety under farmers' field condition. The experiment was laid out in RCBD in six dispersed replications. BARI Kalozira-1 was tested against a local variety as check. At Bogra, BARI Kalgira-1 (1.05 t ha^{-1}) produced higher yield against the local (0.64 t ha^{-1}) check variety. At Faridpur, the higher seed yield of 730 kg ha^{-1} was obtained from BARI Kalozira-1 where as local variety gave 670 kg ha $^{-1}$. The gross margin was about 20% higher in BARI Kalozira-1 over local variety at both the location.

On-farm verification trial of fenugreek at charland

An experiment was conducted at the char land of Debdhunga, Sariakandi, Bogra during the Rabi 2016-17 to evaluate the performance of BARI Methi-1and BARI Methi -2 under farmer's field condition and to popularize among the farmers. BARI Methi-2 (1.44 t ha^{-1}) performed better against the local (0.97 t ha^{-1}) check.

On-farm trial of BARI developed capsicum variety

An adaptive trail was conducted in farmer's field under South Surma upazila, Sylhet during Rabi season of 2015-16 and 2016-17 to evaluate the performance of BARI released capsicum variety. Two varieties of capsicum viz. BARI Mistimorich-1 along with locally popular hybrid California wonder were used in this trial. Between two tested varieties, locally popular California wonder produced higher fruit yield (13.82 t ha^{-1}) and economic return with gross margin (Tk. 556700 ha^{-1}) than BARI variety (9.70 t ha^{-1}).

Validation of intercropping squash with maize under varying planting system

The experiment was conducted at Gopalpur, Sherpur upazilla, Bogra during the Rabi season of 2016-17. The experiment consisted of four treatments, viz., T_1= Maize normal plating (75cm x 25cm), T_2= Maize normal plating (100%) + 1 row squash (Pl. to Pl. 80 cm: 116%) in between 2 rows of maize, T_3= Maize paired row (100%) + 2 row squash (Pl. to Pl. 80cm: (100%) in between 2 paired rows of maize and T_4= Maize paired row (100%) + 1row squash in between 2 paired rows of maize (Pl. to Pl. 1m: 40%). The tested variety was BARI Hybrid Bhutta-9 and Sunny House (squash). The highest maize equivalent yield (23.97 tha^{-1}) was produced by maize paired row (100%) + 2row squash (Pl. to Pl. 80cm: (100%) in between 2 paired rows of maize and the lowest (8.746 tha^{-1}) sole maize. The highest gross return (Tk. 359550 ha^{-1}) and gross margin (Tk. 264990 ha^{-1}) was found from maize paired row (100%) + 2row squash (Pl. to Pl. 80cm: (100%) in between 2 paired rows of maize whereas the lowest gross return (Tk. 131190 ha^{-1}) and gross margin (Tk. 53060 ha^{-1}) was found from sole maize.

Validation of intercropping winter vegetables with sweet gourd

The experiment was conducted at Gopalpur, Sherpur upazilla Bogra during the Rabi season of 2016-17. Four crops combinations viz. T_1=Sole sweet gourd, T_2=100% sweet gourd + 62.5% cabbage, T_3=100% sweet gourd + 62.5% cauliflower and T_4=100% sweet gourd + 62.5% tomato were investigated. The maximum sweet gourd equivalent yield (69.404 t ha^{-1}) as well as the highest gross margin (Tk. 610890 ha^{-1}) was obtained from100% sweet gourd + 62.5% tomato combination whereas the lowest yield (26.56 t ha^{-1}) and the lowest gross margin (Tk. 199970 ha^{-1}) was recorded in sole sweet gourd

Fertilizer management of lentil at charland area of Bhuapur, Tangail

An experiment was conducted under char land situation at the MLT site, Bhuapur, Tangail during Rabi 2015-16 & 2016-17 to find out optimum fertilizer dose for BARI Mosur-6 under farmers' field condition. Five fertilizer doses/packages viz T_1: 24-32-30-18-0.4 kg ha^{-1} N-P-K-S-B (Based on HYG, FRG, 2012), T_2: 21-17-20-0-0 kg ha^{-1} N-P-K-S-B (based on PRC, BARI). T_3: 26-35-20-12-0.3 kg ha^{-1} N-P-K-S-B (Based on STB) T_4: Farmers practice (17-8-19-14-0) and T_5: Native fertility were considered as treatments. Among the treatments, T_3: 26-35-20-12-0.3 kg ha^{-1} N-P-K-S-B (based on soil test) gave the highest seed yield (1.44 t ha^{-1}) followed by T_2: 21-17-20-0-0 kg ha^{-1} N-P-K-S-B (Based on PRC, BARI) (1.315 t ha^{-1}), T_1: 24-32-30-18-0.4 kg ha^{-1} N-P-K-S-B (Based on FRG, 2012) (1.20 t ha^{-1}) and lowest seed yield (0.78 t ha^{-1}) was obtained from T_5 treatment (Control/native fertilizer dose). The gross returns (Tk. 100800 and 91700 ha^{-1}) and gross margins (Tk. 69971 and 62584 ha^{-1}) were higher in soil test basis fertilizer dose and recommended fertilizer dose based on PRC, BARI. The lowest gross return and gross margin (Tk. 54250 and 29125 ha^{-1}) were found from the control plot (control/ native fertility).

Validation on biofertilizer of different legume crops

The experiment was conducted at Kushtia, Jessore, Pabna, Patuakhali, Rangpur, Jamalpur and Faridpur during cropping season of 2016-17 to verify the effect of different fertilizer doses and Rhizobial biofertilizer for lentil (BARI Masur-7), chickpea (BARI Chola-5), mungbean (BARI Mung-

6) and soybean (BARI Soybean-6) cultivation under farmer's field condition. Three treatments viz. T_1= Without Rhizobium inoculant + PKSZn, T_2= With Rhizobium inoculants + PKSZn, T_3= NPKSZn were used in the experiment. Rhizobium inoculant plot with 22-42-20-5 PKSZn produced the highest yield of chickpea (1.12 tha^{-1}) and lentil (1.86 t ha^{-1}) at Kushtia, Lentil at Jessore (1.52 t ha^{-1}), Faridpur (1.58 t ha^{-1}) and Jamalpur (1.58 t ha^{-1}); mungbean (1.7 tha^{-1}) at Patuakhali and soybean ((1.81 t ha^{-1}) at Rangpur. At Pabna, N applied plot out yielded (2.42 tha^{-1}) over Rhizobium inoculant plot (2.32 t ha^{-1}). Gross margin was higher in rhizobium inoculant plot than that of without rhizobium inoculant plot due to lower cost of fertilization in all the locations.

Effect of raised bed planting and potassium application on the mitigation of soil salinity and yield of maize

A field experiment on hybrid maize (cv. BARI Maize-9) was conducted in coastal saline soil at Kuakata, Patuakhali during late Rabi 2016-17 to test the possibility that salinity damage can be reduced by elevating K fertilization rate and to study the effects of planting method and K fertilization interacted on maize yield and nutrient uptake under salt stress condition. Four rates of fertilizer K (Native K, 100% STB K, 125% STB K and 150% STB K) were tested combining with two planting methods (Flat land and Raised bed) in a factorial randomized complete block design with three replications. Other nutrients were also applied following STB method. Prior to seed sowing the salinity level was low (EC: 2.0 dS m-1). But the salinity level increased (2.02 and 10.49 dS m^{-1}) for flat land and raise bed, respectively with time during the growing period. The higher rates of K contributed 05-21% increased yield over control as against 14% with STB dose, which implies the necessity of higher dose of K in salt affected soil in augmenting yield whereas raised bed with higher dose of K (K_4 x M_2) gave numerically better result over other combinations. The contribution of raised bed in combination found 8.25 %. Thus application of 25-50% higher rates of K over present STB dose under raised bed method of cultivation could be useful in minimizing salt stress and maximizing yield of hybrid maize in the study area.

Validation and popularization of a low cost two-wheel tractor operated potato harvester in farmers' field

A low cost two wheel tractor driven potato harvester has been developed with locally available materials in Farm Machinery & Postharvest Process Engineering Division of BARI, Gazipur to facilitate small farmers to harvest their potatoes at low cost. The developed potato harvester is a semi-automatic digging machine consisting of (i) digging blade (ii) conveyer flat chain (iii) Guide plate and (iv) Power transmission arragenment with a dimension of 900 mm x 85 mm x 950 mm. The field capacity of the potato harvester covers daily average. 0.88 ha land depending on operator skinless. Potato harvester requires labour 23 ha^{-1} only instead of 65 labour ha^{-1} in traditional manual method. Total cost of potato harvesting by the potato harvester is Tk. 12735 ha^{-1} but manually harvesting cost is Tk 31987 per ha^{-1}. Potato harvester saved 60.18% potato harvesting cost and 64% labour requirement compare to traditional manual potato harvesting method. Moreover, there are no potatoes remain under the soil. Potato damage percentage is less than 1.1%. Potato farmers always pass risk of bad weather especially harvesting time. So potato harvester can cover large areas within short period of time, escape bad weather uncertainty and sustain potato production stable.

Project-IV Integrated Farming

Integrated farming for improving livelihood of resource-poor farm households in a participatory approach

Integrated farming is a sustainable resource management approach to maximize farm productivity, farm resource use efficiency, employment opportunity, farmers' income and nutrition as well as livelihood of the resource poor farm households. With rapid increasing population and declining agricultural land food and nutrition security of resource poor farm households through integrated farming are gaining priority. The integrated farming activities were carried out in 9 sites at Plain land ecosystem- northern and eastern zone (FSRD site Lahirirhat, Rangpur; Pushpopara, Pabna; Elenga, Tangail; Hatgobindapur, Faridpur and Kusumhati, Sherpur) and Coastal and Rainfed ecosystem (FSRD site Kadamshahar, Barind, Rajshahi; Jalalpur, Sylhet; Rajakhali, Patuakhali and Hazirhat, Noakhali) during the year of 2016-17. The research areas were i) Homestead production system ii) Crops and cropping system iii) Poultry and livestock production system, iv) Fisheries production system and v) Off-farm activities. All components of integrated farming such as vegetables, fruits, cereal crops, livestock, fish and off-farm activities were brought under improved technological intervention and accordingly income were increased from these components. **In plain land ecosystem (northern & eastern zone),** the overall results of those experiments showed that farmers obtained higher yield and economic return from their alternative or improved cropping pattern with improve variety(s) better management approaches. Four improved cropping pattern (Mustard-Boro-T.aman, Wheat-Jute-T.aman, Potato-Boro-T.aman and Mustard-Boro-T.aus-T.aman) trials were conducted in different location of which Potato-Boro-T.Aman gave the highest productivity and economic return (Gross margin Tk. 241683 ha^{-1}**)**. Newly released high yielding crop varieties were also introduced through on farm validation program where farmers obtained higher crop yields and gross margin (Tk. 21235-252500 Tk ha^{-1}). Results of homestead production program revealed that intake of vegetables were markedly increased (avg. 302%) as compared to before intervention (102 kg per farm family per year) by all families included in this system. Average intake of fruits per year was also increased (Avg. 95%) after intervention of the technology as compared to before intervention (137 kg per farm family per year). Existing fruit tree management and new plantation has created a good impact on farm households. Gross margin (avg.249%) over pre intervention (TK. 16003) was increased due to deworming and vaccinaton program of cattle. Mortality of poultry reduced (75-97%) after vaccination. Moreover, farm yard manure (FYM) production and utilization were created a good impact among the farm families. Green fodder (Napier grass) production was found profitable (gross margin Tk. 180150 ha^{-1}) and suitable for the farm families. Among the seasonal fish culture carp polyculture gave higher gross margin (Avg. Tk. 15891pond^{-1}) at farmers' level. From off-farm activities, farmers also earned some extra money (Avg. Tk. 14698 household^{-1}). **In coastal and rainfed ecosystem (southern and north-western zone),** newly released high yielding crop varieties were also introduced through on farm validation program where farmers obtained higher crop yields and gross margin (Tk. 22980-569660 ha^{-1}). Six improved cropping pattern trials were conducted in different location of which Tomato-Boro-T.Aman gave the highest productivity and economic return (Gross margin Tk 265725 ha^{-1}) at Kadamshahar, Rajshahi. Vegetables production was increased maximum at Kadamshahar, Rajshahi (318%) and minimum at Hazirhat, Noakhali (171%) compared to before intervention of the program. Result of this intervention was very encouraging as intake of vegetables by all types of farm families increased (Avg. 216%) remarkably as compared to before intervention (124 kg per farm family per year). Average intake of fruits per year was also increased (Avg. 211%) after intervention of the technology as compare to pre intervention (106 kg per farm family per year). Women participation in agricultural activities increased to a great extent that showed some positive effect on gender equity within the family. After deworming and vaccination against major diseases i.e. Anthrax, Foot and Mouth Disease and Black Quarter reduced and mortality rate of cattle which contributed higher production and gross margin increased in average 116% over pre intervention (TK. 14447). Poultry rearing in the homestead area created a good impact among the farm families as a good source of income. Mortality of poultry reduced (77-91%) after vaccination. In fisheries production system, it was found that farmers sold most (Avg. 63%), consumed about 29% and distributed 8% through their neighbours, relatives and well wishers of the produced fish. Average gross margin obtained per pond about Tk. 15167. Finally, it can be concluded that interventions made in different components exerted a visible positive impact in improving farmers' socio-economic condition and livelihood as well.The daily nutritional requirements of the family members were supplemented considerably due to increased consumption of vegetables and fruits from the homestead gardening and also from fish, chicken and livestock production. Active participation of the farmers' and integration of their available resources in planned way has created a positive impact on improving livelihood of resource poor farm household. The results of FSRD activties imply that by implementing the coordinated approach of farming systems at FSRD sites has brought a good impact on the resource-poor farmers for the betterment of livelihood. Therefore, large scale adoption of integrated farming is deemed imperative for sustainable development of food and nutrition security as well as livelihood improvement of the rural farm households in Bangladesh.

Project V: Socioeconomic Studies

Impact of hybrid maize seed in cereal production system in Bangladesh

The study was undertaken on farmers' perception, production, marketing scenario, and efficiency of hybrid maize farmers in Bangladesh. Data of 400 maize farmers and 40 seed dealers were collected from Lalmonirhat, Dinajpur, Kustia, and Manikganj district. In addition, data of ten leading seed companies were collected for this study. The annual growth rate of area, production and yield of hybrid maize from 1990/91 to 2015/16, were 18.98, 25.42 and 6.43 percent respectively. Demand of maize seed is more than six thousand metric tons in the country, where private sector produced 12 percent, 58 percent seed imported by 10 leading seed companies and the rest amount imported by other seed companies. A total of 25 hybrid maize varieties were found in the study districts. The prominent channels through which the maize moves from producers to the feed mills were i) Farmers-Farias-Wholesalers-Aratdars-Feed mills, ii) Farmers-Wholesalers-Aratdars-Feed mills, iii) Farmers-Aratdars-Feed mills. The per hectare gross return was found higher in Lalmonirhat compared to other districts due to higher yield. Areas under maize competitive crops (Boro rice, wheat, etc) have been shifted to hybrid maize about 7 to 46 percent. The stochastic frontier production model indicated that inefficiency effects were present in hybrid maize production. Hence, technical inefficiency effects have significant impact on output. These results suggest that there is a substantial scope of maize production in the country using hybrid seeds. Farmers are happy by producing maize due to higher yielder.

Study on the utilization pattern and impact of super granular urea (usg) at farmer's field of FSRD site, Tangail

The survey was conducted at FSRD site, Elenga under Tangail district during April to May, 2017. A total of 20 farmers were interviewed with the help of pre-designed survey schedule and face to face interview method. Purposive sampling technique was followed for selecting the sample farmers to know the existing utilization pattern of the granular urea, to know the impact and productivity on different crops produced by granular urea, to know the profitability and to identify the constraints and potentiality of granular urea. The study covered Boro and T.aman rice crop. Enterprise costing technique was followed in calculating cost and return. The average cost of production of Boro was estimated Tk 73324/ha and Tk 78525/ha for without USG and with using USG, respectively. On the other hand it was found Tk49716/ha and Tk 55055/ha for T.aman rice cultivation without USG and with USG application, respectively. The average yield of Boro rice was recorded 5.61 t/ha and gross return was Tk 124200/ha for without using USG while it was 5.93 t/ha and Tk131600 for Boro by applying USG. The yield of T.aman rice was estimated 4.20 t/ha and gross return was Tk 93000/ha while 4.5 t/ha and Tk 101000/ha for T.aman by applying USG. Applicator of granular urea is not available in local markets with little bit high price and line sowing/planting is labour consuming which is also necessary for the application of granular urea. Despite these problems there is ample scope to increase crop yield with controlling natural pollution by ensuring availability of granular urea at farm level.

Baseline survey report of cropping system intensification in salt-affected coastal zone of Bangladesh and West Bangal, India project (BARI part)

The baseline survey was conducted at two upazilas namely Dacope under Khulna and Amtali under Barguna district to know the present status of different crop production and to generate baseline standpoint/indicators for future impact assessment of the project during January to March 2017. The survey revealed that there is enough scope of improvement by imposing appropriate technologies in the study areas for the resource poor farm households. A large number of farmers using local varieties. High yielding modern varieties of different crops should be ensured in the study areas for higher yield. Salt and submergence tolerant variety should be developed by the respective research organizations

A survey on farm level seaweed collection/ utilization in the coastal areas of Cox's Bazar

The study was undertaken in Cox's Bazar-Teknaf coastline to evaluate the present status of seaweed collection/cultivation and their use in Bangladesh. A total of 37 respondents were randomly selected from Cox's Bazar sadar, Teknaf and Ukhiya upazila for primary data collection. The study revealed that people have limited knowledge about cultivation procedure and use of seaweed. Although some species of seaweed are naturally grown in some coastal area of Bangladesh, but continuous uprooting and harvesting declining the production rate of seaweed day by day. In the winter season the respondents on an average collect 1738 kg/household/season raw seaweeds. No organized and systemic chain between seaweed producer and consumer has not developed. However, this survey has identified several places where seaweed can grow maintaining the natural environment. Despite of having some constraints of seaweed cultivation and marketing, development of skilled and trained seaweed grower and government attention in seaweed cultivation and in export, and development of more public awareness will help to increase the production and use of seaweed.

15 PLANT PATHOLOGY

Fungal Disease

Collection, isolation, molecular characterization and determination of genetic diversity of *Sclerotinia sclerotiorum* isolates collected from different sources in Bangladesh

An experiment was conducted at Molecular Plant Pathology Laboratory of Plant Pathology Division, BARI, Gazipur with fourteen isolates of *Sclerotinia sclerotiorum* for its molecular characterization and determination of genetic variation among the isolates collected from different hosts and locations. All the DNA samples of the isolates were amplified properly and those were clearly verified by agarose gel electrophoresis. Amplified DNA was sent for sequencing. In case of genetic variation study, during the rep-PCR using ERIC21 primer, it was clear that there was a distinct variation among the isolates.

Prevalence of seed borne pathogens of ornamental plants grown in Bangladesh

The experiment was conducted in the laboratory of Plant Pathology Division, BARI, Gazipur. The prevalence of fungi associated with seeds of some local flower namely cosmos, marigold, silvia and corm of gladiolus collected from three different locations (Jessore, Savar and Gazipur) were recorded. The Jessore's seeds were better than the others considering incidence of fungi as compared to all other seeds tested. But silvia from Jessore was the lowest affected seed and marigold from Savar was the highest affected seed. *Fusarium* sp., *Aspergilus flavus*, *Aspergilus niger*, *Rhizopus stolonifer*, *Alternaria alternata*, *Penicillium* sp., *Curvularia* sp., *Chaetomium* sp. and *Cladosporium* sp. were found to be associated with the flower seeds. The percent of seed borne infection ranged 4-28%, 5-32.5%, 3-29% and 11-25% in case of cosmos, marigold, silvia and gladiolus respectively. The result showed that the higher germination of cosmos (86.5%), marigold (77.5%), and silvia (54.5%) were obtained from Jessore and gladiolus (80%) from Gazipur.

Study on the seed borne fungi of some selected spices crops

The experiment was conducted in the laboratory of Plant Pathology Division, BARI, Gazipur to identify the seed borne fungi of five different spices crops viz. coriander, black cumin, fenugreek, fennel and radhuni collected from four different districts (Jessore, Chapai Nawabganj, Rangpur and Khagrachari) of Bangladesh. From the study, 11 different fungi representing 08 genera were detected. The identified fungi were- *Alternaria alternata*, *Alternaria radicina*, *Alternaria zinniae*, *Aspergillus flavus*, *Aspergillus niger*, *Bipolaris* sp., *Cladosporium* sp., *Colletotrichum* sp., *Curvularia lunata*, *Fusarium* sp. and *Penicillium* sp. Among them *Penicillium* sp., *Fusarium* sp., *A. alternata*, *A. niger*, *Cladosporium* sp. and *A. radicina* were predominant.

Formulation of plant products for the management of seedling diseases of some selective vegetable crops

The experiment was conducted in the laboratory and net house of Plant Pathology Division, BARI, Gazipur. Garlic (*Allium sativum*) tablet was formulated as the botanical fungicide in the Plant Pathology Lab of Plant Pathology Division, BARI, Gazipur which had proved to be effective in plant disease control, specially for seed borne diseases. Efficacy of formulated garlic tablet was tested on the germination and seedling diseases of brinjal, tomato and chilli. The germination percentage of the three studied crops was increased when seeds were treated by garlic tablet. The seedling diseases of brinjal, tomato and chilli were significantly reduced by seed treatment with garlic tablet.

Screening of tomato lines/varities against early blight disease under natural field condition

An experiment was conducted in the research field of Plant Pathology Division, BARI during 2016-17 cropping season to evaluate the performance of 12 tomato lines/varieties against early blight disease. Disease appeared late in the season but spread quickly and uniformly. Three tomato lines showed highly resistant reaction. Among others, one line was seems to be resistant and two lines/varieties were moderately resistant.

Screening of groundnut germplasm against white mould disease under natural field condition

An experiment was conducted at Regional Agricultural Research Station, Jamalpur during 2016-2017 to find out resistant lines of groundnut against white mould disease. Twenty eight different lines were compared with two varieties Jingha and Dhaka-1. Among the 30 screening materials K-2, 06285, 07219 and 96175 lines showed minimum disease incidence (2%) wherer the maximum disease incidence 33% was found in line 06423 followed by line 06237 and 99235.

Screening of lentil lines against stemphylium blight disease under inoculated condition

The experiment was conducted at BARI, Gazipur. A set of 20 lentil entries were evaluated against stemphylium blight disease in this experiment. The twenty lentil test entries were BD-3804, BD-3808, BD-3810, BD-3940, BD-3945, BD-3948, BD-3975, BD-3980, BD-3985, BD-3986, BD-3995, BD-4028, BD-4088, BD-4090, BD-4091, BD-4094, BD-4134, BD-5958, BD-5959 and BD-5983 which were collected from PGRC, BARI. A susceptible check variety BARI Masur-1 was used. Lowest (1.00) stemphylium blight disease score and highest (1331 kg/ha) yield was recorded in BD-5959 and the highest (3.67) disease score with lowest (826.60 kg/ha) yield was recorded in the check variety BARI Masur-1.

Morphological, physiological and molecular characterization of *Colletotrichum* sp. the causal organism of chilli anthracnose

The experiment was conducted in the experimental field and laboratory of Plant Pathology Division, BARI, Gazipur. The study was undertaken to know the behavior of the disease and biology of the pathogen so as to device better management practices of the diseases to avoid losses. Four isolates were collected from Ishurdi, Bogra sadar, Rangpur sadar and Gazipur sadar. Based on morphological characteristics, all the 4 isolates were identified as *Colletotrichum capsici*. Colony colour varied from light to pale white. Colonies varied in their cultural behavior ranging from cottony to fluffy with regular margins. Average conidial size of isolates ranged from 18.09-32.70 x 2.88-4.56 µm. All the isolates developed symptoms of anthracnose and lesions on detached fruit. Disease score varied 5.00-7.00 in red chilli and 3.00-5.00 to green chilli. Lesions appeared 3 days after inoculation in red chilli and 7 days in green chilli.

Efficacy of fungicides in controlling white mould disease of country bean

The experiment was conducted at RARS, Burirhat, Rangpur during Rabi season, 2016-2017. A susceptible variety BARI Shim 1 was sown for the trial. Effect of five different fungicides on disease incidence of white mould and yield of bean were studied. Five fungicides of different groups like Bavistin (0.2%), Secure(0.2%), Rovral(0.2%), Indofil(0.2%) and Ridomil(0.2%). All the fungicidal treatments had significant effect on reduction of disease incidence as well as positive impact on yield of the crop compared to control. Secure and Rovral were found better than others for controlling white mould disease of bean.

Efficacy of new fungicides in controlling purple blotch disease of onion

The experiment was conducted in the laboratory of Plant Pathology division, BARI, Gazipur using nine fungicides and one control the treatment were (1. Azonil 50 WP (Azoxystrobin + chlothanil) 1 ml

/ L water, 2. Emerge 50 WP (copper oxichloride) 5 gm/ L water, 3. Hossacop (Copper Oxichloride) 5 gm/ L water, 4. Hyprodion 50 WP (Ipridion) 2 gm/ L water, 5. Hyprozim 50 WP (Carbendazim + Iprodion) 1 gm/ L water, 6. Mcvo 75 WP (Trifloxostrobin + Tebuconazol) 0.5 g/ L water, 7. Monaxe 50WP (Pseudomonus + fluerescens) 5 gm/ L water, 8. Trooper 75 WP (Toicyclazol) 2 gm/ L water 9. X-Tracare 300 EC (Difenoconeazol +Propiconozol) 0.5 ml/ L water, and 10. Control against *Alternaria porri* causes as purple blotch of onion. Among the fungicides higher mycelia growth reduction were recorded by Azonil 50 EC, X-Tracare 300 EC and Mevo75 WP.

Efficacy of new fungicides in controlling anthracnose/die back of chilli

The experiment was conducted in the laboratory of Plant Pathology Division, BARI, Gazipur. Ten treatments with nine fungicides and one control (1. Awal 72 WP (Zineb + Hexaconazol) 2 gm/L water, 2. Cuproxate 34.5 SC (Tri Basic copper sulphate) 1 ml/ L water, 3. Dizim 50 WP (Carbendazim) 2gm/ L water, 4. Emerge 50 WP (Copper oxichloride) 5 gm/L water, 5. Fair up 32.5 SC (Azoxystrobin + Difenoconeazol) 1ml/L water, 6. Monaxe 0.5 WP (Peudomonas + flurescns) 5 gm/ L water, 7. Sunzoxy 32.5 SC (Azoxystrobin + Difenoconeazol) 1ml/L water, 8. Veer 70 WP (Tricyclozole + Fenoxynil) 2gm/L water, 9. X-Tracare 300 EC (Difenoconazol + Propiconazol) 1 ml/L water, and 10. Control) were used to evaluate the efficacy in controlling *colletotrichum capsici* causing die back disease of chilli during 2016-2017 cropping season. Among the treatments, the lowest fungal growth was found in Cupraxate 34.5 SC, Diazim WP, Emarge 50 WP, Veer 70 WP and X-Tracare 300 EC.

Efficacy of new fungicides in controlling phomopsis blight disease of brinjal

The experiment was conducted for controlling phomopsis blight of brinjal at Gazipur during the cropping season 2016-17. There were 7 treatments viz., T_1= Lux clean (0.2%), T_2= Indothane 72 wp (0.2%), T_3= Green row (0.2%), T_4= Shield 75 wp (0.2%), T_5= Turbo 50 wp (0.2%), T_6= Awal 72 wp (0.2%) and T_7= Control with three replications. Effect of six different new fungicides were tested on disease incidence of phomopsis blight of brinjal. All the fungicides had significant effect on reduction of disease incidence of the crop compared to control. Lux clean ‘and Turbo were found better than others for controlling phomopsis blight of brinjal

Biological control of rhizome rot disease of ginger

The experiment was conducted in the field of Plant Pathology Division, BARI, Gazipur during winter, 2016 with four treatments along with three replications. Treatments were (T_1) control, (T_2) soil drenching with Microtech 1 and (T_3) soil drenching with Decoprima 100 g / 33m^2 and (T_4) Ridomil gold at 60 and 100 days after germination + Clorox at 80 and 120 days after germination. Ridomil gold + Clorox and Decoprima showed significant effect in rhizome rot disease reduction in field and at storage conditions and also had significant effect on yield.

Evaluation of new microbial product in management of fusarium wilt of brinjal

The experiment was conducted at two locations; in the farmer field at Sherpur, Bogra during Summer 2016 and an other farmer field at Shajahanpur, Bogra during Winter, 2016 in RCBD with three treatments along with three replications. Treatments were (T_1) control, (T_2) soil drenching treatment with carbendazim 3g/ l and (T_3) soil drenching with Decoprima 100 g/ 33m^2. Decoprima showed much effectiveness in disease reduction (77.32-81.17%) and gave higher yield 47.57 to 49.05 t/ha at the farmer’s field of locations.

Effect of Tricho-compost against seedling blight disease of barley caused by *Sclerotium rolfsii*

An experiment was conducted in the field of Plant Pathology Division, BARI, Gazipur during 2016-17. There were 6 treatments viz. (i) seed treatment with Provax (ii) seed treatment with *Trichoderma* spore suspension-1 (iii) seed treatment with *Trichoderma* spore suspension-2 (iv) soil amendment with Tricho-compost-1, (v) soil amendment with Tricho-compost-2 and (vi) control. The formulated biological control agent *Trichoderma harzianum* was mass cultured in two composts materials viz.

organic compost and vermi-compost to observe its effectiveness against seedling blight disease of barley. The chemical fungicide Provax was also used for seed treatment. Soil amendment with Tricho-vermi-compost and Tricho-organic-compost are considered to be the best treatments in reducing seedling mortality and in increasing yield of barley. Seed treatment with chemical fungicide Provax was found similar effect for decreasing seedling mortality and enhancing plant growth and yield of barley. Seed treatment with chemical fungicide, Provax showed better performance against the disease and its effect was at per with the soil amendments with vermin-compost and organic compost in reducing seedling mortality and increasing yield of barley.

Screening of organic composts for mass culturing of *Trichoderma harzianum* to be used against soil-borne pathogen *Sclerotium rolfsii* of lentil

The experiment was conducted in the field of Plant Pathology Division, Bangladesh Agricultural Research Institute, Gazipur. There were 6 treatments viz. (i) seed treatment with Provax (ii) soil amendment with organic compost (iii) soil amendment with Tricho-organic compost (iv) soil amendment with vermi-compost and (v) soil amendment with Tricho-vermi-compost and (vi) untreated control. The experiment was conducted to observe the suitability of organic compost and vermi-compost for mass culturing of bio-control agent, *Trichoderma harzianum* and its effectiveness against foot and root rot disease of lentil caused by *Sclerotium rolsfii* and *Fusarium oxysporum*. The formulated *T. harzianum* cultured in two different compost viz. organic compost and vermin-compost is designated as Tricho-organic-compost and Tricho-vermi-compost. The present study revealed that soil amendment with Tricho-vermi-compost and Tricho-organic-compost are considered to be the better treatments in reducing seedling mortality and in increasing yield of lentil. Seed treatment with chemical fungicide Provax showed better performance against the disease and its effect was similar organic compost and vermin-compost in reducing seedling mortality and increasing plant growth and yield of lentil.

Screening of organic composts for mass culturing of *Trichoderma harzianum* to be used against soil-borne pathogen *Sclerotium rolfsii* of groundnut

The experiment was conducted in the field of Plant Pathology Division, Bangladesh Agricultural Research Institute, Gazipur. There were 6 treatments viz. (i) seed treatment with Provax (ii) soil amendment with organic compost (iii) soil amendment with Tricho-organic compost (iv) soil amendment with vermi-compost and (v) soil amendment with Tricho-vermi-compost and (vi) control. The experiment was conducted to observe the suitability of organic compost and vermi-compost for mass culturing of biocontrol agent, *Trichoderma harzianum* and its effectiveness against foot and root rot disease of groundnut caused by *Sclerotium rolsfii*. The present study revealed that soil amendment with Tricho-vermi-compost and Tricho-organic-compost are considered to be the best treatments in reducing seedling mortality and in increasing yield of groundnut. Seed treatment with chemical fungicide Provax showed better performance against the disease and its effect was at per with the vermin-compost and organic compost in reducing seedling mortality and increasing yield of groundnut.

Integrated management of banana diseases

The study was conducted to assess the performance of different chemical fungicides and non chemical agents for the management of sigatoka and panama disease of banana during January to December 2016 at two locations of BARI research field and RARS, Ishurdi with 7 treatments viz. T_1= pplication of poultry refuse @ 5 ton/ha,T_2= Application of mustard oil cake @ 600 kg/ha, $_3$= Application of sesame oil cake @ 600 kg/ha T_4= Application of neem oil cake @ 300 kg/ha T_5= Application of *Trichoderma* compost @ 3 ton/ha T_6= Sucker treatment with Bavistin 0.2% and T_7= Control. Among the organic soil amendments and biocontrol agent *Trichoderma* perform better in both disease management and yield parameters at two locations. For the chemical management of sigatoka disease of banana six different groups of fungicides have been used with a control. Among the chemicals Tilt 250 EC, Nativo 75 WG and Knowing 50 WP were better at two locations.

Study on the relationship of weather factors in developing alternaria blight of mustard

An experiment was conducted to observe the relationship of weather factors in developing alternaria blight of mustard at Gazipur during cropping season 2016-17 at Plant Pathology Field, BARI, Gazipur with six date of sowing viz. 21 October, 1 Nov, 11 Nov, 21 Nov, 1 Dec. and 11 Dec. The highest disease score 4.6 was recorded in December 11 sowing followed by 4.3 in December 01 sowing. The lowest disease score 2.7 was recorded in November 01 sowing. The highest seed yield 1.62 ton/ha was observed in November 01 and the lowest seed yield 0.86 ton/ha was found in December 11 sowing. Temperature and humidity of 01-20 November was congenial for mustard cultivation in Bangladesh to minimize the alternaria blight disease.

Improvement of jackfruit tree through an integrated approach

Jackfruit seeds were sown in 2013 in the net house of Plant Pathology Division, BARI, Gazipur which gave a number of seedlings and became jackfruit tree with the change of time. One of those jackfruit trees seems to be dead in January, 2017. Intensive care and treatment has been taken to recover the tree from that time. Different Pathological tests were done to explore the causes of death of the tree where a fungus called *Phomopsis* spp. was found. In addition, jackfruit tree was suffering from malnutrition and water scarcity. The root system of the tree did not develop properly also. Some Physiological tests also done to know the health conditions of the tree. It was proven in the physiological test that the jackfruit tree did not die fully. Without any delay the apparently dead tree kept into glass house for better treatment with the transfer from polybag to plastic pot. Jackfruit was recovered by applying the proper fungicide (Bavistin 0.2%), irrigation and fertilizer.

Management of white mold diseases of lettuce

The experiment was conducted in the pot house of plant Pathology Division at BARI, Gazipur during 2016-17 cropping seasons. Seven treatments were used such as T_1 = Mustard oil cake in the soil @ 0.5 t/ha before 20 days of planting T_2= Neem oil cake (2.5kg/ha) in the soil before 7 days planting, T_3= Poultry refuse (6t/ha) in the soil before 7 days planting, T_4= Tricho–compost (2.5kg/ha) in the soil before 7 days planting, T_5=. Rovral (0.2%) foliar spray, T_6 =Thining of leaf and T_7 =Control. Each pot soil was inoculated with *Sclerotinia* rolfsi grown on wheat grain colonized with @ 15 g/pot before 30 days of seed sowing. BARI Lettuce-1, seedling was used as planting material in this experiment. The treatment of control gave the highest percent of severity (76.28%) of white mold diseases whereas the lowest percent of diseases severity (23.45%) was observed from the Neem oil cake treatment. There was no significant difference among the treatments incase of leaf number. In contrast, there was no significance different among the Tricho–compost, thinning leaf and Control treatments in case of plant height. On the other hand, 45.67 g and 44.33 g dry matter weights were seen from Neem oil cake and Rovral treatments respectively. Among the treatments, use of Neem oil cake as a soil amendment before 7 days of planting and foliar spray of Rovral at fifteen days after interval gave satisfactory results to reduce the white mold disease of lettuce.

Management option of sclerotinia rots diseases of marigold

The experiment was conducted in the Plant Pathology field of BARI during 2016-17 cropping season. The treatments were T_1 = Soil drenching with Contaf 5 EC (0.1%) T_2 = soil application of Tricho-compos (2.5 t/ha) T_3 = Fungicidal spray with Rovral (0.1%), T4 = MOC (0.5t/ha) applied as a soil treatment T_5 = Application of poultry refuse in the soil @ 6 t/ha before 20 days of planting T_6 = Soil and stem application of Provex (1 g/L) T_7 = Control (Farmers practices). The highest diseases incidence (08.12%) was recorded from Control treatments whereas the diseases incidence from the Rovral was the lowest (20.41%). Similarly, the highest percentage of disease severity was recorded from control treatment whereas the diseases severity from the Rovral treatment was the lowest.

Moreover, Rovral gave the satisfactory results not only the uninfected flowers and PDI but also decreased of disease.

Effect of different treating agents for controlling post harvest fruit rot of banana

The experiment was conducted at Plant Pathology Laboratory, BARI. Two banana varieties namely Sagor and Sabri were selected for the study. Six different treating agents viz. Ethanol (5%), Clorox (5%), NaCl (2%), Detergent (5%), Sunstin (0.05%) and Autostin (0.05%) for three minutes were used. All the treatments except Sunvit performed remarkably better than control. Detergent treatment retained yellowish green peel for ten days and increased self life more than 13 days without any disease infection that was similar to Autastin. Among the dealings, detergent treatment was found to be best in terms of reduction of disease incidence, improvement of fruit quality, extend of self life as well as health risk of end user.

Management of anthracnose disease of chilli

The experiment was conducted at the field of Plant Pathology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur to evaluate some management options to manage anthracnose disease of chilli under natural field condition. Five treatments viz. i) planting in raised bed, ii) space planting (50x50cm), iii) application of a biopesticide 'Micro tech-1' @ 10ml/L water, iv) application of Metaril 72 wp @ 2g/L water and v) control were applied. All the treatments minimized the disease significantly providing higher yield compared to control. Lowest (25.45%) plant infection was obtained from planting in raised bed plots which was statistically similar with the Metaril treated plot. Highest (73.14%) number of chilli plant was infected by anthracnose in control plot at 85 DAT. Highest reduction in percent plant infections at 85 DAT was obtained when it was planted in raised bed. The highest (456.3g) yield plant^{-1} was obtained also from planting in raised bed treated plots at 85 DAT. Lowest (211.1g) plant^{-1} was obtained from control plot. Highest (54%) yield was increase when it was planted in raised bed.

Screening of phytopathogenic fungus, *Sclerotium rolfsii* for mycoviruses with virocontrol potential

A screen of plant pathogenic fungal strain *Sclerotium rolfsii* that was among the most destructive soil-borne fungal pathogens of over 500 plant species for viruses with virocontrol potential was carried out in the Virology laboratory of Okayama University, Japan. Four hundred and seventy two *S. rolfsii* strains were collected from a variety of crops such as wheat, bush bean, tomato, eggplant, lentil, chickpea, eggplant and okra from different location of the country. After imported in Japan, these fungal strains were cultured on potato dextrose agar (PDA) for extraction of DNA and dsRNA. The extracted nucleic acids were tested for presence of viruses using rolling circle amplification (RCA) (for DNA viruses) and cellulose column chromatography (for RNA viruses). Once detected, *S. rolfsii* viruses were further characterized molecularly. A total of 120 strains were tested, none were found positive for DNA viruses. The partial cDNA sequences of the dsRNA segments isolated from the strain SR336 were obtained. BlastX database search with the partial sequence from SR336 isolates showed similarities with randorna like virus. To screen the present of randorna like virus in *S. rolfsii* isolates, 64 isolates which showed one or two distinct dsRNA segments/band were selected from 472 isolates of *S. rolfsii*. The isolates of *S. rolfsii* were tested by RT-PCR using randorna virus specific primers**.** Results showed that out of 64 isolates 13 (20.31%) showed randorna virus positive strain and rest of the isolates have absent of randorna virus. Subsequent necessary analyses will be carried out by the host laboratory

Screening of CIP potato clones against late blight disease

During 2016-17 cropping season, screening of twelve CIP potato clones viz viz. 213, 214, 217, 218, 223, 224, 225, 229, 231, 232, 235 and 239 including check varieties (BARI Alu 8 and BARI Alu 25) against late blight (*Phytophthora infestans*) under natural inoculum pressure was carried out in farmers' field, Khaturia, Domar, Nilphamari. Results revealed that all clones including checks were highly susceptible to late blight except clone 235 was susceptible and the range of AUDPC values were 666.50 to 1424.00. The highest AUDPC values (1424.00) were recorded from clone 217. Clone 225 yielded the significantly highest (17.32 t ha^{-1}) which was significantly different from all others and the lowest in BARI Alu 25 (3.35 t ha^{-1}).

Effect of planting time and spray schedule on development of stemphylium blight of lentil

The experiment was conducted at the experimental field of Plant Pathology Division, RARS, Jessore during Rabi 2016-17 to find out optimum planting time and actual spray schedule with fungicide for controlling stemphylium blight of lentil in a split plot design. There were four main treatments such as sowing date 25^{th} October, 5^{th} November, 15^{th} November and 25^{th} November, 2016 and four subplot treatments such as spraying at 40 DAS (Days After Sowing), 50 DAS, 60 DAS and 70 DAS. Among the treatments MP2, where planting date was 05 November 2016, and SP3, where the spray schedule started at 60DAS showed better performance for reducing disease severity and increasing yield. The highest yield (1610 kg/ha) was found in MP2 x SP3 which was statistically similar to MP2 x SP2 (1580 kg/ha) and the lowest (728 kg/ha) in MP4 x SP4 followed by MP4 x SP3.

Management of stemphylium blight of lentil using fungicides

The experiment was conducted at Regional Agriculture Research Station, Jessore during Rabi 2016–2017 to find out the effective fungicides for controlling stemphylium blight of lentil. Six treatments such as, T_1=Rovral 50WP, T_2= Secure 600WG, T_3= Companion, T_4= Indofil M 45, T_5= Nativo 75WP and T_6= Control were applied form the first appearance of the disease at 10 days intervals. Rovral performed the lowest disease severity (2.00) followed by Nativo. The highest yield (1650 kg/ha) was recorded in T_1 (Rovral) treated plots which was statistically similar to T_5 (Nativo) treated plot and the lowest yield (730 kg/ha) was obtained from T_6 (control) plot. The highest MBCR was observed in T_3 (Companion) treated plot (7.79) followed by T_2 (Secure) and T_1 (Rovral) treated plot and the lowest in T_4 (Indofil) treated plot (4.40).

Efficacy of different new fungicides for controlling alternaria leaf spot of cabbage

The experiment was conducted at Regional Agriculture Research Station, Jessore during Rabi 2016–2017 to find out the effective fungicides for controlling alternaria leaf spot of cabbage. There were 7 treatments including control such as T_1= Rovral 50 WP, T_2= Secure 600 WG, T_3= Iprozim 26 WP, T_4=Amistar Top 325 SC, T_5= Folicur 250 EC, T_6= Nativo 75 WG, T_7= Control. Rovral performed the lowest disease severity (2.00) followed Iprozim and Amistar Top. The highest yield (80.26 t/ha) was found in T_1 (Rovral) treated plot which was statistically similar to T_3 (Iprozim) and T_4 (Amistar Top) treated plots, respectively. On the other hand, the lowest yield (45.26 t/ha) was found in T_7 (control) plot. The highest MBCR was observed in T_3 (Iprozim) treated plot (20.41) followed by T_1 (Rovral) treated plot and the lowest in T_2 (Secure) treated plot (5.23).

Efficacy of fungicides against white mold disease of mustard

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during rabi season 2016-17 to find out the effectivity of fungicides for controlling white mould /sclerotinia rot disease of mustard. Seven fungicides viz. Rovral 50 WP, Score 250 EC, Folicur 250 EC, Indofil M 45, Contaf 5 EC, Secure 600 WG and Tilt 250EC were tested for their performance against the disease. All the fungicides showed significantly better performance over control. The lowest incidence of white mould disease (2.63%) was found in Folicur 250 EC (2ml/l) treated plots where as the highest (13.34%) was recorded in untreated control plots. Moreover, Folicur 250 EC (2ml/l) treated plots provided the highest yield (1.55t/ha).

Screening of rapeseed-mustard lines for resistance to *orobanche*

An experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during 2016-17 to observe the magnitude of resistance of 31 oilseed *Brassica* germplasms namely BJ-1111536,

BJ- 1111536(12), BJ- 1111536(7)-1, BARI-Sharisha-11, BJ-1111536-9-2, BJ-1111536-12-5, BJ-DH-05, BJ-1111536-12-5, BJ-66(Y), BARI-Sharisha-16, Nap-1007, Nap-10014, Nap-0660, Nap-10017, Nap-1005, Nap-0762, Nap-0885, Nap-0865, Nap-0876, Nap-0733-1, BC-100614-84, BC-99-22, BC-05-118, BC-100614(4)-12, BC-100614(4)-7, BC-100614(4)-9, BC-0-5115, BC-100614(3)-1, BC-100614(4)-2, BC-100614(4)-5 and Tori-7 against *orobanche*. Among the evaluated germplasms, six lines/varieties viz. BARI-Sharisha-11, BJ-1111536-9-2, BJ-DH-05, BARI-Sharisha-16, BC-100614(4)-12 and BC-0-5115 showed resistant reaction, 9 lines showed moderately resistant reaction and the rest of 16 lines including check showed susceptible reaction against *orobanche.*

Screening of rapeseed-mustard varieties/lines against alternaria leaf blight disease

The experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during 2016-17 season to observe the resistance/tolerance of 31 mustard germplasms viz. Nap-10015, Nap-1005, Nap-1007, Nap-10014, Nap-10012-1, BARI-Sharisa-13, Nap-11008, Nap-10009, Nap-10017, Nap-205, BC-0-5115, BC-05-118, BC-99-22, BC-100614(8)-9, BC-100614(3)-1, BARI-Sharisa-14, BC-100614(8)-4, BC-100614(4)-7, BC-100614(4)-9, BC-100614(7)-2, BJDH-05, BJDH-20, BARI-Sharisa-11, BJDH-01, BJ-66(y), BJ-1111536, BJ-1111536(12), BJ-1111536(12)-5, BJ-1111536(7)-1, BJ-1111(7)-7 and Tori-7 (check) against alternaria leaf blight disease. Five lines namely Nap-10015, Nap-1005, BARI-Sharisa-13, Nap-11008 and Nap-205 showed moderately resistant (MR), 25 lines showed moderately susceptible (MS) reaction and rest one check variety Tori-7 showed susceptible (S) reaction. The highest yield (1.98 t/ha) was obtained in BJDH-05 while, the lowest (0.58 t/ha) was found from BC-100614(7)-2.

Determination of spraying time and number of spray with Rovral and Secure to control stemphylium blight of lentil

The experiment was conducted at RARS, Ishurdi, Pabna during rabi season 2016-17 to find out the optimum time of spray and number of spraying for effective management of stemphylium blight disease of lentil. The experiment was carried out following split plot design with three replications. Initial spray time (January 20 and January 30) of rovral mixed with secure (1:1) were used in main plot and number of spray (single spray, double spray at 7 days interval, three spray at 7 days interval, four spray at 7 days interval and control) were used in sub plot. Significantly lowest disease score (0.67) was recorded from four spray at 7 days interval starting from January 20 and differed significantly with all the rest treatments while the highest score (7.00) was recorded from both control. Significantly higher yield of 1842 kg/ha was harvested from four spray at 7 days interval starting from January20 which is statistically similar to three spray at 7 days interval starting from January 20 and lowest was recorded in water spray starting from January 20 (untreated control) which is statistically identical to water spray starting from January 30 (untreated control).

Management of foot and root rot disease of bush bean

The trial was conducted at Regional Agricultural Research Station Ishurdi, Pabna during 2016-17 to find out an effective management practices against foot and root rot disease of bush bean. Six treatments viz. T_1= seed treatment with Provax @ 2.5 g/kg seed, T_2= soil treatment with poultry liter @ 5 t/ha, T_3= spraying of Provax +Bavistin (1:1) at crown region- 2 times, T_4= seed treatment with Provax + Soil treatment with poultry liter + spraying of Provax +Bavistin (1:1) at crown region, T_5= seed treatment with Provax + spraying of Provax + Bavistin (1:1) at crown region, T_6= soil drenching with sapnil (0.5%) and T_7 = control were tested for their performance against the disease. All the treatments showed significantly better performance over the control. The lowest incidence (6.03%) of disease was recorded in seed treatment with Provax + soil treatment with poultry liter + spraying of Provax + Bavistin (1:1) at crown region treated plots and highest was found in control. The highest yield (16.95 t/ha) was recorded in seed treatment with Provax + soil treatment with poultry liter +

spraying of Provax + Bavistin (1:1) at crown region treated plots while the lowest (8.91 t/ha) yield was obtained in untreated control plots.

Screening of potato varieties and germplasm against late blight disease

The trial was carried out in Khaturia village, Domar, Nilphamari during the winter seasons of 2016-2017. Seeds of BARI Alu 7 (Diamant), BARI Alu 25 (Asterix), BARI Alu 46 (LB-7), BARI Alu 47, BARI Alu 48, BARI Alu 49, BARI Alu 50, BARI Alu-53 (LB-6), BARI Alu-57 (8.73), BARI Alu 62, BARI Alu 63 (Vivaldi) and BARI Alu 77 (Sarpomira) and germplasm (Alouette and Carolus) were planted December 09, 2016. Late blight of potato, caused by *Phytophthora infestans* (Mont.) de Bary, is one of the most important diseases of potato (Solanum tuberosum L.) in Bangladesh and none of the variety/germplasm was found immune. Four varieties like BARI Alu 46, BARI Alu 53, BARI Alu 57 and BARI Alu 77; and two germplasm viz. Alouette and Carolus found highly resistant. The highest yield (48.38 t ha^{-1}) was recorded from BARI Alu 46. Alouette and Carolus yielded 36.58 t ha^{-1} and 35.91 t ha^{-1} respectively.

Effect of nutrients to control purple blotch and tip-burn of onion in sustainable agriculture

The experiment was conducted in the field of Plant Pathology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur to evaluate the efficacy of plant nutrient for the development of purple blotch disease and tip-burn of onion. There were 9 treatments viz. T1= soil application during seedling transplanting + spray MP fertilizer at 60 and 75 DAP (@20 g/l), T2= soil application during seedling transplanting + spray TSP fertilizer at 60 and 75 DAP (@20 g/l), T3= soil application during seedling transplanting + spray Bo fertilizer at 60 and 75 DAP (@20 g/l), T4= soil application during seedling transplanting + spray $ZnSO_4$ fertilizer at 60 and 75 DAP (@20 g/l), T5= soil application during seedling transplanting + spray $CaSO_4$ fertilizer at 60 and 75 DAP (@20 g/l), T6= soil application during seedling transplanting + spray $CuSO_4$fertilizer at 60 and 75 DAP (@20 g/l), T7= soil application during seedling transplanting + spray granular silica gel at 60 and 75 DAP (@20 g/l), T8= soil application during seedling transplanting + spray $MnSO_4$ at 60 and 75 DAP (@20 g/l) and T9= control. Eight different treatments viz. potassium (MP fertilizer), phosphorus (TSP fertilizer), boron (Bo fertilizer), zinc (ZnSO4 fertilizer), calcium ($CaSO_4$), copper ($CuSO_4$), silicon (silica gel) and manganese ($MnSO_4$) were tested against purple blotch disease and tip-burn of onion. Among the nutrients MP, TSP, silica gel, $ZnSO_4$ and $CaSO_4$ were performed better than other treatments for reducing purple blotch disease severity, tip-burn and increasing plant growth as well as yield of onion. So, plant nutrients potassium, phosphorus, boron, zinc and silicon have significant effect on tip-burn and purple blotch disease development and increased plant growth as well as yield of onion.

Effect of nutrients to control purple blotch disease and tip-burn of garlic in sustainable agriculture

An experiment was conducted in the field of Plant Pathology Division, BARI, Gazipur to evaluate the efficacy of plant nutrient for the development of purple blotch disease and tip-burn of onion. Eight different treatments viz. potassium (MP fertilizer), phosphorus (TSP fertilizer), boron (Bo fertilizer), zinc (ZnSO4 fertilizer), calcium ($CaSO_4$), copper ($CuSO_4$), silicon (silica gel) and manganese ($MnSO_4$) were tested against purple blotch disease and tip-burn of onion. Among the nutrients $MnSO_4$, silica gel, MP, TSP and $ZnSO_4$ were performed better than other treatments for reducing purple blotch disease severity, tip-burn and increasing plant growth as well as yield of garlic. So, plant nutrients silicon, manganese, potassium, phosphorus and zinc have significant effect on tip-burn and purple blotch disease development and increased plant growth as well as yield of garlic.

Survey on choanephora blight disease of chilli

A survey was conducted at three districts namely Bogra, Jamalpur and Kishoregonj as major area of chilli cultivation and its production. Four upazilla of Bogra viz. Sadar, Gabtoli, Shibgonj and Shajahanpur, two upazilla of Jamalpur viz. Sadar and Melandha, and three upazilla of Kishoregonj viz. Karimgonj, Tarail and Hossainpur were surveyed to record the incidence of choanephora blight disease of chilli. A total of 10 farmers fields were surveyed in each upazilla. The highest incidence of the disease was observed in Jamalpur sadar (34 %) and the lowest was found in Bogra sadar (20 %). It was 31% and 28 % in Karimgonj and Tarail upazilla of Kishoregonj district.

Survey on gummosis disease of different fruit crops

A survey was conducted at seven districts namely Mymensingh, Tangail, Gazipur, Khagrachori, Rangpur, Thakurgaon and Pirozpur on gummosis disease of fruit crops. One upazilla of each district were surveyed to see the incidence of gummosis disease of fruit crops in Bangladesh. A total of 10 farmers fields were surveyed in each upazilla. The highest 78% incidence of gummosis disease of jackfruit was observed in Khagrachori Sadar and the lowest 3% disease incidence was found in Thakurgaon. In mango, the highest percentage of gummosis disease was 36% at Khagrachori and the lowest 4% was found at Thakurgaon. Rangpur is the highest gummosis disease prone area for wood apple, pumello, malta and lemon. The gummosis disease was 50% in golden apple at Pirozpur.

Survey, isolation and identification of diseases of dragon fruit

A survey was carried out in dragon fruit orchards of Hill Agricultural Research Station (HARS), Khagrachari during the year 2016-17. In recent years, dragon fruit crop *(Hylocereus undatus*) has become increasingly important in Bangladesh. However, the dragon fruit was reported to be seriously infected with several diseases and causing serious losses. From this survey two types of disease were identified from dragon fruit viz. i) stem rot and ii) soft rot. In this study, 82% of dragon fruit plants were found to be infected by stem rot whereas 91% of total plants were attacked by soft rot disease. Through molecular characterization with pathogenicity test it is confirmed that *Diaporthe phaseolorum* and *Fusarium fujikuroi* are causal agents of stem and soft rot disease of dragon fruit, respectively. These two fungi viz. *D. phaseolorum* and *F. fujikuroi* are new record for causing stem rot and soft rot disease of dragon fruit, respectively.

Isolation and identification of different diseases in pomegranate (*Punica granatum*)

An experiment was carried out to isolate and identify fungal and bacterial disease in pomegranate in Rajshahi region during 2016-17 and found two new diseases. Wilt of pomegranate is an important fungal disease and its causal organism, *Ceratocystis fimbriata* were successfully identified on the basis of morphological characteristics of culture and conidial shape of the pathogen. Pathogenicity was confirmed following standered procedure. Bacterial disease *Xanthomonas axonopodis* pv. *punicae* were isolated from infected leaf and fruit. Morphological and Biochemical characteristics of bacteria were found after completion of different test. Both are first report on pomegranate in Bangladesh.

Round black lesion, a new disease caused by *Pestalotiopsis psidii* on guava fruit in Bangladesh

A distinct diseased symptom like ‘Round black lesion’ was recorded on guava fruit (*Psidium guajava*) in the farmers’ field of Rajshahi region, Bangladesh during last three years. Primarily *Pestalotiopsis psidii* was identified as a causal organism on the basis of morphological and physiological characteristics of the pathogen. Pathogenicity was confirmed following standered procedure. In different country, *Pestalotiopsis* spp. infected guava fruit disease was called scab, canker, scabby canker, or anthracnose. Round black lesion symptom caused by *Pestalotiopsis psidii* on guava, found in this study was completely different from other symptoms described previously in different literature. This symptom developed not only open guava fruit it also infected severely within polyethylene bagged fruit in the tree. There was no report described about this special type symptom on guava in the world. So, due to special type diseased symptoms on guava, new term ‘Round black lesion’ was used for the first time and it was first report in the world where causal organism was *Pestalotiopsis psidii.*

Fruit rot of cowa (*Garcinia cowa*): a new record in Bangladesh

Initially sunken and water-soaked lesions appeared on the lower portion of the cowa fruit which expanded rapidly on fruit surface. Fully expanded lesions were soft, sunken and range color from dark red to tan to black. After few days the lesion extended to upper portion of fruit and later on the fungus infected the maximum portion of fruit and then dropped out the infected fruit.The fungal colonies on PDA showed dull white mycelia covered with greyish black single acervuli. These contained hyaline conidia, 1-celled, straight, cylindrical, ends rounded with dimensions 6-15X 3-4 µm long. The pathogen was *Colletotrichium gloeosporioides*. Symptom was developed on inoculated fruit after one week of inoculation.Traditionally, *Colletotrichum* species have been identified and delimited on morphological characters; several features have been utilized by taxonomists including size and shape of conidia and appressoria; presence or absence of setae, sclerotia, acervuli and teleomorph state and cultural characters such as colony colour, growth rate and texture. These criteria alone are not always adequate for reliable differentiation among *Colletotrichum* species due to variation in morphology and phenotype among species under environmental influences. To overcome the inadequacies of these traditional schemes, molecular techniques should be used to characterize and identify taxa within *Colletotrichum.* For this reason fruit samples were sent to Plant Pathology Laboratory, Gazipur for nucleic acid analyses and that should be provided the most reliable framework to classify *Colletotrichum*, as DNA characters are not directly influenced by environmental factors.

Management of damping-off disease in vegetable seedlings under floating agriculture

The experiment was conducted at RARS, Rahmatpur, Barisal during 2016-2017. Management of damping-off disease in vegetable seedlings under floating agriculture by seed treatment with Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2%, seed treatment with Provax-200 (Carboxin + Thiram) @ 0.2%, seed treatment with Topzim @ 0.1%, seed treated with Timseen Tm (n –alkyl dimethyl benzyl) @ 0.1%, Tema/ball soaking with Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2%, Tema/ball soaking with Topzim super 75 WDG(Imidachloropid + Thiram +Carbendazim) @ 0.1%, Tema/ball soaking with Timseen Tm (n –alkyl dimethyl benzyl) @ 0.1%, seed treatment with Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2% and Tema/ball soaking with Ridomil gold MZ 68 WG (Mancozeb + Metalexyl) @ 0.2%, seed treatment with Provax-200 (Carboxin + Thiram) @ 0.2% and Tema/ball soaking with Topzim @ 0.1%, seed and Tema/ Ball treated with Timseen Tm (n –alkyl dimethyl benzyl) @ 0.1% and seedling sprayed with Timsen@ 0.1% under natural condition .From this experiment, it was found that seed and Tema/ball treated with Timseen Tm (n –alkyl dimethyl benzyl) @ 0.1% and seedling sprayed with Timsen@ 0.1% effectively control the damping-off disease in vegetable seedlings.

Effect of different cultural and chemical options for controlling foot rot of lentil

The experiment was conducted at RARS, Rahmatpur, Barisal during 2016-17 to find out an effective management practice for the management of foot and root rot disease of lentil. Ten treatments including control were viz. seed treatment with Provax-200 (Carboxin + Thiram) @ 0.25%, seed treatment with Topzim super 75 WDG (Imidachloropid + Thiram + Carbendazim) @ 0.1%, seed treated with *Trichoderma* sp. @ 5%, flood irrigation after 1DAS, flood irrigation after 11DAS, flood irrigation after 21DAS, soil drenching with Provax-200 (Carboxin + Thiram) @ 0.2%, soil drenching with Secure 600 WG (Fenamidone+ Mancozeb)@ 0.2% and soil drenching with Topzim @ 0.1%. The lowest foot and root rot (15.73 %) was obtained from seed treatment with Topzim super 75 WDG (1g/kg seed) and the highest incidence (48.90 %) was obtained from untreated control. The highest no. of pod/plant(54.67), 1000 seed weight(18.36 g) and yield (1472 Kg/ha) were recorded in seed treatment with Topzim super 75 WDG (1 g/Kg seed) and the lowest of these parameters were obtained from untreated control plots.

Management of gummy stem blight (black rot) on watermelon

The experiment was conducted at RARS, Rahmatpur, Barisal during 2016-2017. Management of gummy stem blight on watermelon was conducted by seed treatment with Ridomil gold MZ 68 WG

(Mancozeb + Metalexyl) @ 0.2%, Nativo 75 WG (Tebuconazole+Trifloxystobin) @ 0.1%, Jibal 77 WP (Copper Hydroxide) @ 0.2%, Karishma 28 SC (Azoxystrobin + Cyproconazole) @ 0.2%, Defence 35 SC (Carbendazim + Hexaconazole) @ 0.1%, Aimstar Top 325 SC (Azoxystrobin +Difenoconazole) @ 0.1%, Autostin 50 WDG @ 0.2 %, Filia 525 SE (Tricyclazole + Propiconazole) @ 0.1 %, Secure 600 WG (Fenamidone+ Mancozeb) @ 0.2% and Bordeaux paste (1:1:10). From this experiment, it was found that seed treatment with Bordeaux mixture, sprays of Jibal (0.2%) /Secure (0.2%) /Karishma (0.2%) can effectively control the gummy stem blight on watermelon.

Survey of diseases of malta in southern region

A survey was conducted at major malta growing areas in Barisal and Jhalakathi districts. The areas to be covered in the survey were shown based on their importance in malta fruit production. A structured questionnaire was designed to capture information on agronomic practices, sources of planting materials, management practice and economic loses were caused by the diseases. The questionnaire was pretested on small holder farmers in Barisal and Jhalakathi districts. Respondents in different upazilla recorded all the disease with the highest incidence being dieback (80%) followed by shooty mold (60%) and gummosis (40%).

Effect of *bacillus oryzicola* yc7007 to regenerate grating projection overcoming nursery diseases

The *in vitro* experiment was conducted at the Regional Agricultural Research Station, Hathazari, Chittagong during the period 2016-2017 to get the successful grafting without the infection of nursery diseases. Novel species *Bacillus* sp. YC7007 was subjected to regenerate the reunion of scion and rootstocks. Strain YC7007 (2.0×10^7 CFU/ml) revealed significantly ($P < 0.01$) good performance in the different plant growth promoting parameters viz. number of leaves (8.95 ± 0.27), length of scion (15.8 ± 0.39 cm) and fresh weight (1.75 ± 0.05 gm / scion) followed by control number of leaves (5.65 ± 0.17), length of scion (9.2 ± 0.20 cm) and fresh weight (1.14 ± 0.02 gm / scion). YC7007 showed the consistent grafting success 91-95% followed by control 73-77.34% in the rough lemon and kalamanshi root stock respectively. Strain YC7007 showed the good grafting projection almost free nursery diseases. In the rough lemon root-stock, Plant growth promotion (PGP) was highly expressed compared with the kalamanshi, however numerical disease severity was higher in the rough lemon compared with kalamanshi. About 88-90% fungal scab disease, 49-55% bacterial canker and 100% dieback of malta were controlled by the bacterial treatment.

Management of sooty mould of mango

The *in vivo* experiment was conducted in the established mango orchard of Regional Agricultural Research Station, Hathazari, Chittagong during 2016-17. Five treatments (Imidacloprid, Thiovit, Copper oxycloride, Cypermethrin with Propiconazole and with Control) where all treatment showed good performance in controlling sooty mould of mango disease compared with control. Among the treatments, Thiovit and Admire showed better performance in reducing the sooty mold of mango. After 1st spray, the lowest disease severity was found in Thiovit (0.54) followed by Admire (0.57); and in case of 2nd spray, the lowest disease severity was found in Admire (0.31) followed by Thiovit (0.33).

Integrated management of wilt complex disease of chili

The trial was conducted at Regional agricultural Research Station Ishurdi, Pabna during rabi season 2016-17 to find out an effective management practices against wilt complex disease of chili. Eight treatments viz. T_1= seedling treatment with Bavistin + soil drenching with Bavistin @ 0.2%, T_2= soil application with stable bleaching powder @ 20 kg/ha, T_3= soil application with calcium nitrate @ 1% solution, T_4= soil treatment with poulty litter (5t/ha), $T_5=T_1+T_2+T_3$, $T_6= T_1+T_2+T_4$, $T_7= T_1+T_3+T_4$, T_8= control were tested for their performance against the disease. All the treatments showed significantly better performance over the control. The incidence of wilt complex disease of chili ranged from 8.33% – 25.83% while the highest was recorded in control plot and lowest was found in treatment T_7. The highest yield (2124 kg/ha) was recorded in treatment T_7 while the lowest was obtained in control plots.

Screening of potato germplasm against late blight disease

A total of seventeen (17) lines of potato including two resistant check varieties BARI Alu 46 and BARI Alu 53 at RARS, Burirhat, Rangpur during *Rabi* season of 2016-17 following randomized complete block design (RCBD) having three replications were evaluated under natural condition against late blight disease. Most of the tested lines were found susceptible against late blight. But the two resistant check varieties BARI Alu 46 and BARI Alu 53 and two test lines Alutte and Carolous were found resistant.

Evaluation of potato late blight management utilizing host plant resistance and frequency of fungicide application

An experiment was undertaken at Regional Agricultural Research Station, Burirhat, Rangpur during the rabi season of 2016 – 2017 to observe the effect of spray frequencies of fungicide (Mancozeb) in controlling potato late blight disease and establish an appropriate spray interval for resistant and susceptible potato variety. There were two resistant varieties namely BARI Alu-46 and BARI Alu-53 and a susceptible variety Diamant. Four spray frequency of fungicide (Dithane M 45@ 0.2%) were 1. seven spray with 7 days interval 2. Five spray with 10 days interval 3. Four spray with 15 days interval 4.Three Spray with 20 days interval and one unsprayed plot were also maintained for each variety.From the results it is revealed that disease severity was increased as the frequency of spraying decreased . In case of yield, higher yield was obtained from higher spray frequency but in case of BARI Alu 46 more or less similar yield was obtained from all the frequencies.

Effect of planting time on the late blight disease of potato in the resistant and susceptible variety/lines

The experiment was conducted during the rabi season of 2016 – 2017 at Regional Agricultural Research Station, Burirhat, Rangpur to observe the effect of planting time on late blight disease and yield of potato. There were three planting time and four varieties in this experiment. The planting time was 15 November, 30 November and 15 December. Out of four test varieties there were three resistant varieties namely BARI Alu-46, BARI Alu-53, Sarpomira and a susceptible variety Diamant. The results indicated that late blight severity was increased with the concomitant decreased of yield due to delayed planting. The resistant variety BARI Alu 46 gave the highest yield with lowest disease. The highest yield (38.97 t/ha) was obtained from resistant variety BARI Alu 46 with lowest disease at 30 November planting.

Yield loss assesment of resistant and susceptible variety of potato due to late blight disease

The trial was conducted during the rabi season of 2016 – 2017 at Regional Agricultural Research Station, Burirhat, Rangpur to asses the yield loss of susceptible and resistant varieties of potato due to late blight disease . There were two resistant varieties namely BARI Alu-46 and BARI Alu-53 and a susceptible variety Diamant to determine yield loss. Four spray schedules were maintained in this experiment Four spray schedule of Mancozeb (Dithane M 45@ 0.2%) were one time spray; two time spray; three time spray and four time spray. One unsprayed plot was maintained for each variety. Among the varieties the lower disease were observed in the two resistant varieties than the susceptible variety. From the results it was observed that in case of yield the highest yield 67.06 t/ha was obtained from the resistant variety BARI Alu-46. The yield of other resistant variety (BARI Alu-53) was also higher than the susceptible variety Diamant. Highest yield reduction i.e 51% was obtained in the susceptible variety. The lowest yield reduction 26.45% was obtained in the resistant variety at zero spray.

Up scaling and validation of rhizome rot disease management of ginger

The experiment was conducted to assess the disease severity and yield of ginger during December/2015 to January/2017. Fourteen upazillas of Nilphamari, Rangpur, Tangail, Bogra, Lalmonirhat and Mymensingh districts were selected with the objectives to select ginger growers and trained up them about the ginger diseases; to make understand the farmers about the infected and healthy seeds and to separate them; and finally to provide management packages of the disease in the field during next year cultivation. The main emphasis of the farmers training was to let them know how to select healthy seeds before sowing in practical. Then it was discussed step wise to set up the application of different inputs such as seed treatment with Bordeaux mixture; spraying Bordeaux mixture in standing crop. The disease incidence and yield significantly differed among the locations. The highest disease incidence was recorded from Taragonj followed by Badargonj and the lowest in Ghatail in up scaling program and it ranged from 19.15-6.46%. The highest yield was recorded in Ghatail followed by Kishoregonj among the project areas. The disease incidence in the farmers plot (Control) was ranged 27-49.70% and the yield in control plot was poor due to heavily infected seed materials. The disease incidence and yield also differed significantly among the locations of newly adopted areas. The highest disease incidence was recorded from Lalmonirhat (20.87%) and the lowest in Muktagacha (7.90%). The highest yield was recorded in Dimla (14.93%) and the lowest in Lalmonirhat (8.28%) among the adoption areas.

Nematode Disease Management

Screening of neem products against root-knot nematode, *Meloidogyne incognita* of tomato

The experiments were conducted in the field of Plant Pathology Division, BARI during 2015-16 cropping season with 7 treatments namely i) Furadan (F) 5G @ 45 kgha^{-1}, ii) soil application of neem leaf powder (1:10 w/v), iii) soil application of neem leaf extract (1:10 w/v), iv) soil application of neem seed extract (1:10 w/v), v) soil application of neem oil (1:10 v/v), vi) soil application of neem oil cake @ 600 kgha^{-1} and vii) control to evaluate the neem based products such as neem leaf powder, neem leaf extract, neem seed extract, neem oil and neem oil cake for the management of root knot nematode of tomato caused by *Meloidogyne incognita*. Root-knot nematode infested field soils were treated with those neem based product as well as chemical nematicide Furadan 5G. It was revealed that all the treatments gave appreciable reduction of gall development on roots and increased plant growth parameters such as shoot and root growth as well as yield of tomato. Among the treatments, neem seed extract and neem oil cake appeared to be the best amended materials for reduction of root-knot nematode disease incidence and improvement of plant growth as well as getting higher yield of tomato. Application of neem leaf extract and neem leaf powder were also better as chemical nematicide Furadan 5G in reducing root-knot nematode disease incidence and increasing plant growth as well as yield of tomato.

Management of root- knot disease of tomato plant through the application of nematicides and different organic amendments

The field experiment was conducted at Regional agricultural Research Station Ishurdi, Pabna during rabi season of 2016-17 to find out an effective management practices for controlling of root-knot nematode (*Meloidogyne incognita*) of tomato. Six treatments viz. T_1= furadan 5G @ 25 kg/ha, T_2= poulty litter @ 5t/ha, T_3= mustard oil cake @ 800kg/ha, T_4= Furadan + Poulty litter, T_5= Furadan + mustard oil cake and T_6= control were used in this experiment. The highest gall index (4.33) was found in control plots and the lowest (0.33) was recorded in Furadan 5G+ poultry litter treated plots. Furadan 5G in combinations with poultry litter produced the highest yield (38.73 t/ha) whereas, the lowest yield (26.29 t/ha) was recorded in untreated control plots.

Bacterial Disease Management

Collection, isolation and preservation of bacterial wilt pathogen from different hosts

Samples were collected from different tomato, brinjal and ginger growing areas. A total of 19 samples were collected from surveyed area of which 5 from brinjal, 3 from tomato and 11 from ginger. The pathogen was isolated on TZC medium (Tetrazolium chloride) and multiplied on CPG (Casien peptone glucose) medium. The plates were then incubated at 28^0C for 48 hours. Bacterial colonies from each plate were further sub-cultured and pure bacterial colonies were transferred to CPG slants incubated at 28^0C for 48 hours and preserved at 4^0C for further work. Nineteen samples were collected from surveyed area, 5 from brinjal, 3 from tomato and 11 from ginger. The pathogens were isolated on specific medium and pure bacterial colonies were preserved as type culture.

Bacterial spot: a new disease of tomato in Bangladesh

Bacterial spot infected fruit samples were collected from research fields of Plant Pathology Division and the pathogen was isolated following the standard methods. The pathogenecity test was done on healthy fruits of tomato. Apparently healthy fruits were surface sterilized by chlorox. One loopful of pure bacterial colonies was inoculated on tomato skin by using sterile tooth-pick. The inoculated area was wrapped with moist cotton. Inoculated fruits were kept on moist blotter on a beaker, covered with aluminum foil to maintain high humidity and incubated at room temperature (30 ± 2^0C). After seven days of incubation characteristic symptoms of bacterial spot developed on inoculated fruit skin, which were almost similar to the symptoms appeared on fruits under natural conditions. Based on pathogenecity test the disease was confirmed as bacterial spot and the causal bacterium as *Xanthomonas campestris.*

Yield loss assessment of ginger due to bacterial wilt based on physical seed sorting

An experiment was conducted for controlling bacterial wilt of ginger in two locations viz. one at Gazipur and another one at RARS, Burirhat, Rangpur. There were 5 treatments viz., T_1= 5% seed infection, T_2= 10% seed infection, T_3= 20% seed infection, T_4= 100% seed infection and T5= Control (Farmer's practice/Farmers saved seeed) with three replications. Local variety of ginger was sown both at Gazipur and Rangpur. Effect of five different categories of ginger seeds on germination were recorded. All the categories of seeds had significant effect on increased of germination of the crop compared to 100% percent diseased seeds were sown. Five percent infected seed showed the highest germination percentage followed by 10 % infection seed. The lowest germination was observed in 100% seed infection.

Survey of canker disease of citrus in major citrus growing region in Bangladesh

Citrus fields were surveyed at different location of Sylhet region covering Sylhet, Moulavibazar and Habigang districts. During survey three gardens were surveyed from each village. Randomly ten plants were selected and five fruits from each plant were recorded for disease severity for calculating PDI. A total 13.45 acres of area were surveyed. More or less all the varieties of citrus were found to be susceptible to the bacterium. During survey, an average 26.13% disease incidence and 21.55% disease index was observed.

Effect of time of lime application on the development of common scab and potato yield

The experiment was conducted in known common scab disease of potato infested farmers' field, Khaturia, Domar, Nilphamari during 2015-2016 and 2016-2017 having five treatments viz. 1. liming before T. aman rice plantation, 2. liming 30 days before potato plantation, 3. liming 20 days before potato plantation 4. liming 10 days before potato plantation 5. no liming or control was conducted at farmer's field, Domar, Nilphamari to know the effect of liming on the development of common scab and yield of potato and also to find out suitable timing for effective use of lime. Use of lime significantly influenced common scab and slightly increased potato yield. The trend of disease incidence and severity was decreasing as the gap between liming and time of potato planting is increasing. The significantly highest disease incidence (45.98% and 62.09%) and severity (16.82 and 22.75) was recorded from liming 10 days before potato plantation treatment in 2015-2016 and 2016-2017 cropping year respectively. The highest tuber yield like 36.97 t ha^{-1} (2015-2016 cropping year) and 31.15 t ha^{-1} (2016-2017 cropping year) was harvested from liming before rice cultivation treatment and the lowest 33.21 t ha^{-1} and 28.12 t ha^{-1} in 2015-2016 and 2016-2017 respectively, was from without liming treatment.

Screening of potato varieties against soil borne diseases (common scab and stem canker & black scurf)

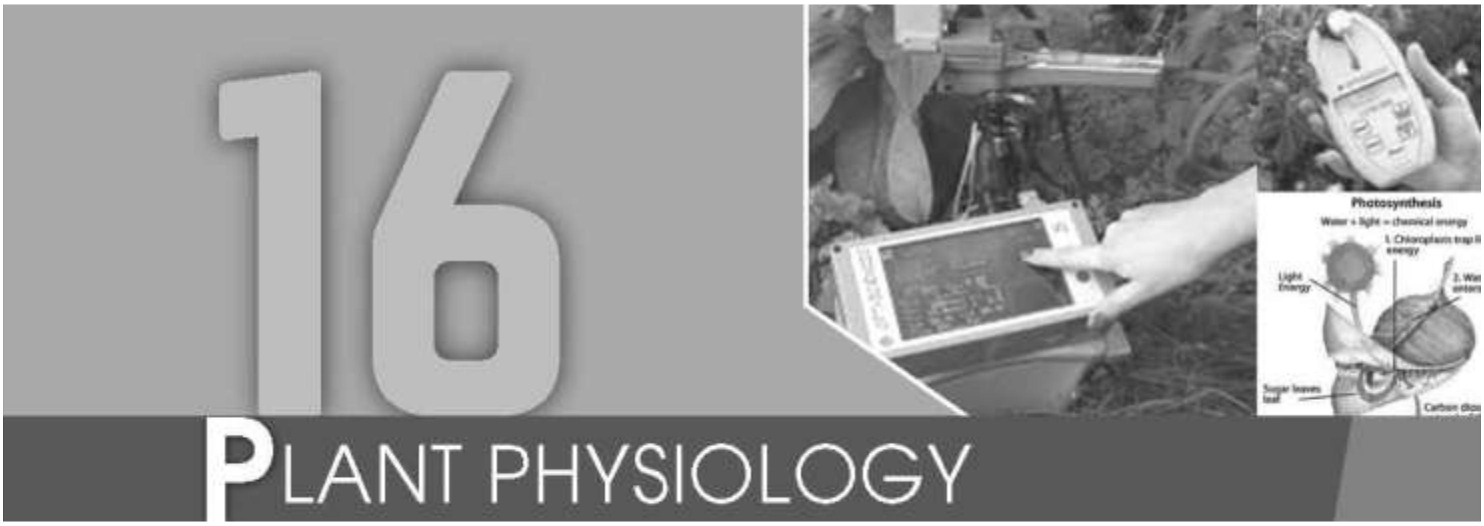
The trial was carried out in known common scab and black scurf infested sandy loam soil in Khaturia village, Domar, Nilphamari during the winter seasons of 2015-2016 and 2016-2017. There were twenty six potato varieties / germplasm were evaluated against common scab and black scurf disease under natural inoculum pressure at farmers' field. Significant variation among the varieties became well pronounced in tested parameters. No varieties / germplasm was found immune to *Streptomyces* spp. BARI Alu 13 (Granola), BARI Alu 29 (Courage), BARI Alu 36 (4.26 R), BARI Alu 41, BARI Alu 46, BARI Alu 56, BARI Alu 59 (Metro) and BARI Alu 61 exhibit good level of resistance against common scab for both cropping seasons and out of these BARI Alu 59 was minimum affected where common scab incidence viz. 1.11% and 3.94% and severity viz. 0.39 and 0.80 was in 2015-2016 and 2016-2017 respectively. Eleven varieties like BARI Alu-13 (Granola), BARI Alu-35 (4.5 W), BARI Alu-36 (4.26 R), BARI Alu-40 (4.45 W), BARI Alu 41, BARI Alu-46 (LB-7), BARI Alu-53 (LB-6), BARI Alu 56, BARI Alu 59, BARI Alu-60 (Vivaldi) and BARI Alu-61 (Volumia) showed resistant against black scurf during both cropping seasons of them BARI Alu-60 (Vivaldi) and BARI Alu-61 (Volumia) were highly resistant i.e. there was no black scurf disease. Significantly highest (49.05 t ha^{-1}) and lowest (31.52 t ha^{-1}) tuber yield was harvested from BARI Alu-40 (4.45 W) and BARI Alu-29 (Courage) respectively in 2015-2016. In 2016-2017 cropping season, BARI Alu-13 (Granola) yielded the significantly highest 48.0 t ha^{-1} and lowest yield (24.17 t ha^{-1}) was from BARI Alu-60 (Vivaldi).

Screening of cip potato clones against soil borne diseases (common scab and stem canker & black scurf)

There were twelve CIP potato clones were evaluated against common scab and black scurf disease under natural field conditions with two BARI released potato varieties BARI Alu-8 and BARI Alu-29 as check at farmers' field, Khaturia, Domar, Nilphamari during 2016-17 cropping season. Significant variation among the clones and varieties became well pronounced in tested parameters. No clones / checks were free from common scab. The range of common scab incidence and severity of CIP clones were 7.65 to 27.52 and 1.63 to 6.41 respectively while the significantly lowest disease incidence 3.65% and severity 0.72 was recorded from BARI Alu-29 (check). Only CIP clone 232 was free from black scurf disease. The significantly highest black scurf disease incidence (11.37) and severity (3.28) was in check BARI Alu-8 (Cardinal). The range of black scurf incidence and severity of CIP clones were 0.00 to 5.40 and 0.00 to 1.20 respectively. Significantly highest (45.12 t ha^{-1}) and lowest (22.74 t ha^{-1}) tuber yield was harvested from clone 239 and clone 223 respectively.

Biological control of wilting by endophytic bacteria *Bacillus* sp. yc7007 in eggplant

The *in vitro* experiment was conducted at the Regional Agricultural Research Station, Hathazari, Chittagong during the period 2016-2017 to control the bacterial wilt caused by *Ralstonia solanacearum* pv. *brinjal* RARS Hat3 in the BARI Bt Begun 3. Its pathogenicity test by the Koch's Postulates and finally its suppressive bioassay by the novel species *Bacillus* sp. YC7007 were conducted. Strain YC7007 (2.0×10^7 CFU/ml) revealed significantly ($P < 0.01$) lower disease severity by 3.27. ± 0.51, than the control 4.67 ± 0.16 by the artificial inoculation in the BARI Bt Begun-3 at autoclaved soil condition. However, at the natural condition, strain YC7007 (2.0×10^7 CFU/ml) revealed significantly ($P < 0.01$) lower disease severity by 3.10 ± 0.32, than the control 4.50 ± 0.17 at the same cultivar. On the contrary, strain was evaluated in the BARI Begun 8 that is naturally resistant to the wilting. Strain showed significantly consistent disease suppression to wilting compared to control.



Physiological and yield responses of some selected rapeseed/mustard genotypes to high temperature stress

A pot experiment was conducted at the research filed of Plant physiology Division, BARI Gazipur during rabi season of 2016-17. Five selected genotypes, namely BJDH-11, BJDH-12, BJDH-20, BARI Sarisha-14 and BARI Sarisha-16 were used as test crop under two sowing dates 15 November and 15 December. The experiment was laid out in randomized complete block design with 10 replications. Plastic pot (top dia: 25 cm, bottom dia: 18 cm and height 25cm; 12 kg soil) was filled up with soil and cowdung (4:1). Ten seeds were sown in each pot according to treatments. Fertilizers were applied @ 100-30-80-20-3-1 kg/ha N P K S Zn B. Half of N and all other fertilizers were applied as basal and remaining N was applied at 20 DAS. Plants from three pots were sampled for leaf area and dry matter measurement at different growth stages. Chlorophyll a, chlorophyll b and total chlorophyll were estimated following Arnon’s method (Arnon, 1949). Leaf samples (3rd leaf from top) were collected on 55 DAS for antioxidant enzyme like Catalyse (CAT), Ascorbate peroxidase (APX) and Peroxidase (POD) determination. Weather data was collected from Weather Station very adjacent to experimental site. At harvest yield and yield components data were collected from three pots and seed yield/plant was calculated. Sowing dates induced temperature variability showed remarkable influences on phenology, leaf area, leaf chlorophyll content, dry matter production and seed yield. Although 15 December sowing crop received lower temperatures (minimum 8.6 to 13 and maximum 24 to 28 ^{o}C) than 15 November sowing crop (minimum 14 to 14.7 and maximum 28 to 28.5 ^{o}C) at flowering stage but reverse was found at grain development stage. Grain development stage of 15 November sowing crop received lower temperatures of the month January (minimum 8 to 16.2 and maximum 24 to 32 ^{o}C), while 15 December sowing crop received higher temperatures at grain development stage (minimum 12 to 24.2 and maximum 26.2 to 32 ^{o}C). As a result 15 December sowing crop matured earlier (4 to 12 days) than 15 November sowing crop. Leaf area/plant was higher in 15 December sowing crop compared to 15 November sowing but total dry matter production was more or less same. Leaf chlorophyll content did not show any remarkable variation due to variation in sowing dates. However, antioxidant activity like Catalyse (CAT), Guaiacol Peroxidase (POD) and Ascorbate peroxidase (APX) were found higher in 15 December sowing crops than that of 15 November sowing and among the genotypes their activity were found higher in BJDH-11 and BJDH-20 and these genotypes also gave higher yield than others. On the basis of growth parameters, antioxidant activity and seed yield the genotype BJDH-11 and BJDH-20 can be selected as terminal high temperature tolerance genotypes. However, further research is needed for confirmation of the results.

Effect of row orientation and plant spacing on canopy light interception, growth and yield of hybrid maize

The experiment was conducted at the Research field of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during rabi season of 2016 -2017. Two row orientations: North-South and East-West direction; and three spacing 60 cm × 20 cm (83333 plants/ha), 45 cm × 20 cm (111111 plants/ha), 45 cm × 25 cm (88888 plants/ha) were used as treatment factors in the study. The experiment was laid out in Split plot arrangement with three replications. Row orientation was assigned in the main plot while spacing in the subplot. BARI Hybrid Maize-9 was use as test crop in the study. Seeds were sown on November 29, 2016 according to treatment. Fertilizers were applied at the rate of 250-55-100-30 kg/ha N, P, K and S as urea, triple super phosphate (TSP), muriate of potash (MoP) and gypsum. One third of N and whole amount of TSP, MOP and gypsum were applied as basal. Remaining 2/3 N was top-dressed at 40 and 70 days after sowing (DAS). Irrigation was given as and when required to maintain adequate soil moisture. Canopy light interception was measured with PAR Ceptometer (LP-80, AccuPAR, Decagon, USA) at different growth stages and plants were sampled for leaf area and dry matter measurement. Yield contributing data were collected from five randomly selected plants from each treatment and yield data were collected from whole plot excluding of border rows. Row orientation did not show any significant influence on leaf area index (LAI) canopy light (Photosynthetically active radiation (PAR)) interception, growth and yield of hybrid maize. But spacing showed significant influence on LAI, PAR interception, dry matter production and grain yield. The highest LAI (>4.5) was found in closer spacing (45 cm × 20 cm i.e. 111111 plants/ha) which intercepted more PAR energy (.95%), produced higher dry matter and ultimately gave higher grain yield (11.97 t/ha) while the lowest LAI, PAR interception, dry matter production and grain yield (10.11 t/ha) was found in wider spacing (60 cm × 20 cm i.e. 83333 plants/ha) which was identical with moderate plant spacing (45 cm × 25 cm i.e. 88888 plants/ha). Results indicated that more 111111 plants/ha would be preferable in respect of PAR interception, growth parameters and grain yield of hybrid maize.

Physiological features and yield response to salinity stress in wheat genotypes

In order to evaluate the salt tolerance characteristic of wheat germplasms, a pot experiment was conducted in vinyl house of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2016-2017. Three selected genotypes/varieties of wheat viz., BAW-1135, BAW-1157 and BARI Gom-29 were tested for their salt tolerance at 15 dS/m of NaCl. The study was evaluated under completely randomized design with four replications. Earthen pots (12 L, 30 cm height) were filled with soil and cow dung in 4:1 volume ratio. Fertilizer at the rate of 120-30-90-15-6-2-1 kg/ha NPKSMgZnB (FRG, 2012) in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid were incorporated in the soil. Ten seeds of each genotype were sown in each pot on 23 November, 2016. Thinning of seedling was done by keeping six plants for each pot at 10 days after sowing. The pots were irrigated with tap water to grow crop without moisture stress. At early vegetative stage (3 weeks after sowing), salt solutions were applied in pot as per treatment. Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water to make 15 dS/m solution. Tap water was used as control and that was 0.25 dS/m. The salt solution was applied with an increment of 2.5 dS/m in every alternate day till respective salinity level of 15 dS/m was attained. Genotypes/varieties greatly affected by salinity in respect to days to heading and flowering, leaf area, SPAD value, plant height, plant dry weight as compared to control. Salinity reduced growth and yield parameters. Under salinity stress, plants had higher Na^+ concentrations in leaves than stems. Importantly, BAW-1135 and BAW-1157 had substantially increased leaf K^+ concentrations; BAW-1157 was more efficient in restricting Na^+ loading in leaf. Moreover, a significant decrease in cell membrane stability index (CMSI) and an increase in malondialdehyde (MDA) were accompanied by a dramatic decrease in total biomass in BARI Gom-29 under salinity treatment. Soluble protein and soluble sugars increased significantly in BAW-1135 and BAW-1157 under salt stress conditions, along with increases in antioxidant activity. Compared with control, salt stress treatment significantly reduced grain yield and 1000-grain weight; however, BAW-1135 and BAW-1157 were less affected than BARI Gom-29. Our results suggest that high tolerance to salinity stress in BAW-1135 and BAW-1157 is closely related to the lower Na^+ and higher K^+, and enhanced soluble protein and sugar contents, improved antioxidative capacity for scavenging reactive oxygen species during stress period.

Antioxidative metabolism and yield performance of wheat in response to drought stress

Vinyl house pot experiment was conducted to investigate genotypic differences in response to drought stress of advance wheat genotypes G6 (AL-3, drought tolerant); G8 (AL-5, drought sensitive) and cv. BARI Gom-25 and BARI Gom-26. Ten seeds of each genotype were sown in each pot on 22 November 2016. Thinning of seedling was done by keeping five plants for each pot at 10 day after emergence. Drought The experiment included two treatments; viz. control (no drought), in which pots remained humid (at a 50-60% water holding capacity throughout growing period); and drought in which 2 L water was added to each pot and the plants were then subjected to drought stress from CRI to before anthesis by withholding irrigation. The experiment was done in Randomized complete block design with nine replications. The results showed that drought decreased plant growth, chlorophyll content (SPAD) and leaf area. Under drought stress, genotype G6 was less suppressed than that of others. Moreover, much more increase in activities of catalase (CAT), guaiacol peroxidase (POD), ascorbate peroxidase (APX) under drought vs control were observed in G6 followed by BARI Gom-25 and BARI Gom-26 than that of G8, with less accumulation of malondialdehyde (MDA) and cell membrane stability index (CMSI). Soluble protein and soluble sugars increased significantly in G6 compared to other genotypes under drought stress conditions. Compared with control, drought stress treatment significantly reduced grain yield and 1000-grain weight; however, G6, BARI Gom-25 and BARI Gom-26 were less affected than G8. These results suggested that high tolerance to drought stress of G6 is closely related to increase capacity of antioxidative performance to scavenge reactive oxygen species (ROS) and thus suppressed level of lipid peroxidation.

Physiological changes in wheat genotypes under high temperature stress at reproductive stage

Heat stress negatively influences the chlorophyll content and grain filling processes in plants. The aim of this study was to know the mechanisms of heat resistance, during reproductive stages. Five wheat genotypes, namely, BARI Gom-25, BARI Gom-26, BARI Gom-30, Pavon 76 and BAW- 1208 were sown in vinyl house of Plant Physiology Division, Bangladesh Agricultural Research Institute, Gazipur, on 28 November 2016. Ten seeds of each genotype were sown in each pot. Thinning of seedling was done by keeping five plants for each pot at 10 day after emergence. Two temperature regimes, namely, normal (average 24°C in open field) and elevated (5±1°C higher compared to open field mean air temperature in polythene chamber) temperature, were created immediately after anthesis to investigate the response of wheat genotypes to heat stress. Elevated temperature cuts back the duration of grain filling by 5 days in BARI Gom-25, BARI Gom-26, BARI Gom-30 and BAW-1208 and 10 days in Pavon 76. Moreover, much more increase in activities of catalase (CAT), guaiacol peroxidase (POD), ascorbate peroxidase (APX) under elevated temperature vs control were observed in BARI Gom-25 and BARI Gom-26 followed by BARI Gom-30 and BAW-1208 than that of Pavon 76, with less accumulation of malondialdehyde (MDA) and CMSI. Soluble protein and soluble sugars increased significantly in BARI Gom-25, BARI Gom-26, BARI Gom-30 and BAW-1208 compared to Pavon 76 under elevated temperature conditions. However, in response to elevated temperature, grain weight was less affected in BARI Gom-25 and BARI Gom-26 and BAW-1208 compared to Pavon 76 indicating their better tolerance to elevated temperature.

Screening of sesame genotypes against waterlogged tolerance at seedling stage

Waterlogging is a common adverse environmental condition that limits plant growth. Sesame is considered a drought tolerant oil seed crop but is typically susceptible to harmful effects from waterlogging. A laboratory experiment was conducted to identify waterlogged tolerance sesame genotypes at seedling stage during April-May, 2017. In the present study, fifteen sesame genotypes were grown under control and waterlogged condition. waterlog was imposed by creating anaerobic condition for 48 h in sealed tube filled with 200 ml distilled water. Data were recorded on various seedling parameters like root length, shoot length, total length and total weight. All the seedling traits showed a decreasing trend in response to waterlogging stress. Sesame genotype BD-10165 was showed the maximum for root length (1.801), shoot length (0.600), total length (2.402) and total weight (3.006) followed by BD-6971. However other genotypes died in waterlogged condition. Similarly, maximum tolerance index (TI) was found in BD-10165, followed by BD-6971 sesame genotype. On the basis of TI and seedling traits against waterlogging stress, BD-10165 and BD- 6971 were selected as relatively waterlogged tolerant sesame genotypes.

Exogenous trehalose increased drought tolerance of wheat seedlings by enhancing glyoxalase system

The present study investigated the role of exogenous trehalose (Tre. 10 mM) in improving drought stress tolerance in two wheat (*Triticum aestivum* L.) genotypes; BAW 1163, a drought sensitive and CSISA DR 30, a relatively drought tolerant genotype. Eight day old seedlings grown in petri-dishes were subject to induce drought by 15% polyethylene glycol (PEG) and observed for 2, 4, 6 days. Drought stress significantly increased the accumulation of methylglyoxal (MG) and decreased the amount of reduced glutathione (GSH) in both genotypes. However, glyoxalase I (Gly-I) and glyoxalase (Gly-II) activities responded differently in drought stressed seedlings. Activities of Gly-I and Gly-II were increased in drought tolerant seedlings (CSISA DR 30), but decreased in sensitive seedlings (BAW 1163) under all days of drought stress. In addition of exogenous trehalose, MG content was decreased whereas the content of GSH and activities of Gly-I, Gly-II were increased in both genotypes over drought stressed seedlings which persist in the seedlings to alleviate the MG toxicity or oxidative damage. Notable, decrease in MG and increases of activities of glyoxalase and contents of GSH were increased more in the genotype CSISA DR 30 compared to BAW 1163 wheat seedlings. The present data suggest that exogenous trehalose enhanced tolerance of wheat genotypes against drought stress through trigger of the glyoxalase system enzymes (Gly-I and Gly-II) and maintenance of reduced glutathione (GSH).

Germination, growth and catalase activity of grasspea germplasm under salinity stress

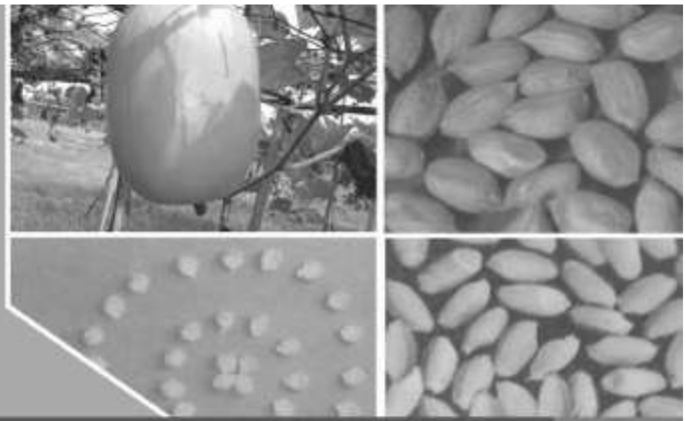
Five grasspea genotypes (BD-3367, BD-3372, BD-3398, BD-4750, and BD-4779) were tested against varying levels of salinity 0, 5 dS/m, 10 dS/m and 15 dS/m in Hyponex solution under laboratory condition during 2016-2017 to study the salt tolerance of the genotypes at germination and seedling stages along with coping performance on enzymatic activity to cope the salinity stress. The salt solution was prepared calculated amount of NaCl in distilled water. Subsequently, plants were transferred to hydroponic culture in a HYPONEX (HYPONEX Osaka, Japan) solution (the HYPONEX: tap water ratio was 1:1000 (w/w)) for an additional quantity (Furukawa, 2012). The P^H of solution was maintained 6-7. Plastic pots were used in the experiment with a diameter of 10 cm and arranged in a completely randomized design (CRD) with three replications. Each pot was supplied with 500 ml of the respective treatment solution. Distilled water (0 dS/m) was used as a control. Seeds were sown on the plastic pots having bolting paper. The germination count was taken after 72 hours of sowing of seeds. Germination percentage (GP), root length (RL), shoot length (SL) and enzymatic activity (Catalase) were significantly affected by salinity. The genotypes BD-3398 showed better performance at 5 dS/m, and 10 dS/m and survived up to 15 days after germination. At 15 dS/m salinity level no genotypes could survive. In case of Catalase (CAT) activity, it was found that due to increase salinity, the catalase activity increased. Grasspea genotype BD-3398 showed the better result than all other grasspea genotypes in Catalase (CAT) activity. Considering all the parameters, results revealed that genotypes BD-3398 is more salt tolerant than other genotypes.

Growth, yield and dry matter partitioning of field pea as influenced by shoot clipping

The experiment was conducted at the research field of Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during rabi season of 2016-17. The experiment was laid out in randomized complete block design with 3 replications. Four clipping treatments were control (no shoot removal), shoot clipping at 30 days after sowing (DAS), 40 DAS and 50 DAS. The unit plot size was 4 m x 3 m. Pre-sowing irrigation was given to bring the soil at field capacity (zoe condition) at sowing. Seeds of BARI Motor-1 were sown on 22 November, 2016. A light irrigation was given in all the plots to ensure proper emergence. Fertilizers were applied at the rate of 20-17-30-3-1.5 kg/ha N-P-K-Zn-B as urea, triple super phosphate, muriate of potash and boric acid. Full amount of all fertilizers were applied as basal. The clippings were done at approximately 5-6 cm above of the main branch. The source-sink relationship among genotypes was different. BARI Motor-1 was tested for its better source-sink relationship after shoot clipping in terms of leaf dry weight and leaf area. The BARI Motor-1 had better source strength because of maximum number of leaves, high dry matter of leaves and high leaf area and had better sink i.e. higher number of pods to accumulate more photosynthates shoot clipping at 30 to 40 DAS based on temperature and climatic condition may be recommended to get better yield along with vegetable. Finally, it may be assumed that the high yielding BARI Motor-1 having a better photosynthetic rate and better mobilization of photosynthates during grain filling contributes to their higher yield.

Screening of chilli genotypes against salinity at seedling stage

Twenty one chilli genotypes (BARI Morich-2, CO 001, CO 0002, CO 0003, CO 446, CO 525-2, CO 611-1, CO 626, CO 631, CO 633, CO 634, CO 635, CO 636, CO 637, CO 640, CO 641, CO 643, CO 644, CO 645, CO 646 and CO 648) were tested against varying levels of salinity 0, 4, 8 and 12 dS/m in NaCl solution under laboratory condition during 2016-17 to identify the salt tolerance chilli genotypes at seedling stages. The salt solution was prepared using calculated amount of NaCl in distilled water. Subsequently, plants were transferred to hydroponic culture in a HYPONEX (HYPONEX Osaka, Japan) solution (HYPONEX -tap water ratio was 1:1000 (w/w)) for an additional month (Furukawa, 2012). The p^H of solution was maintained 6-7. Plastic pots were used in the experiment with a diameter of 10cm and arranged in a completely randomized design (CRD) with three replications. Each pot was supplied with 500ml of the respective treatment solution. Seeds were sown on the plastic pots having blotting paper. The germination count was taken after 72 hours of sowing seeds. Distilled water (0 dS/m) was used as a control. Germination percentage (GP), root length (RL), and shoot length (SL) were found to be affected by salinity. The genotypes CO 637 showed best performance at 4 dS/m and 8 dS/m and survived up to 15 days after germination. At 12 dS/m salinity level no genotypes could survive.



17 SEED TECHNOLOGY

Effect of foliar application of different concentrations of salicylic acid and zinc on seed yield and quality of mungbean

A field study was conducted at the research field of Seed Technology Division, BARI, Joydebpur, Gazipur during 2016-2017 to know the effect of foliar doses of salicylic acid (SA) and zinc on seed yield and quality of mungbean. Four doses of salicylic acid viz., i) control, ii) 60 ppm, iii) 120 ppm, and 180 ppm were assigned as main plot treatment and four doses of zinc viz., i) control, ii) 150 ppm, iii) 300 ppm, and 450 ppm were assigned as sub plot treatment. Salicylic acid was applied at 25 days after sowing and zinc was applied at 30 days after sowing. Zinc was applied in the form of zinc sulphateheptahydrate. SA was dissolved in acetone and maintained volume by adding distilled water. Mungbean variety was BARI Mung-6. Fertilizers @ 30-35-50 kg NPK/ha were applied as basal. Seed germination was conducted by using sand media at 25ºC. Final counting was done after 8 days of seed setting in germination. Salicylic acid @ 180 ppm showed highest number of pods/plant (28) along with highest seed yield (1280 kg/ha) and it was statistically similar with SA @ 120 ppm (Table 1). Zinc showed significant influence on pods/plant only (Table 2). Positive impact on seed germination of mungbean was observed from zinc. Zinc @450 ppm showed maximum seed germination (86%) of mungbean (Table 3).

Table 1. Effect of SA on dry matter production, yield contributing characters and seed yield of mungbean

SA dose (ppm)	DM/ m^2 (g)	Plant density/ m^2 (no.)	Pod/ plant (no.)	Seed/ pod (no.)	1000 seeds weight (g)	Seed yield (kg/ha)
0	248.67	31	21 c	7	45.52	1201 b
60	255.42	31	24 b	8	46.14	1232 b
120	261.48	30	28 a	8	44.19	1275 a
180	265.33	31	28 a	8	45.22	1280 a
Lsd (0.05)	NS	NS	*	NS	NS	*

Table 2. Effect of zinc on dry matter production, yield contributing characters and seed yield of mungbean

Zinc dose (ppm)	DM/ m^2 (g)	Plant density/ m^2 (no.)	Pod/ plant (no.)	Seed/ pod (no.)	1000 seed weight (g)	Seed yield (kg/ha)
0	250.81	29	22 c	7	45.46	1222
150	257.72	31	24 b	8	45.46	1240
300	261.98	31	27 a	7	44.74	1262
450	260.39	31	26 a	8	45.48	1264
Lsd (0.05)	NS	NS	*	NS	NS	NS

Table 3. Seed germination of mungbean as affected by foliar application of SA and Zinc

SA dose (ppm)	Seed germination (%)	Zinc dose (ppm)	Seed germination (%)
0	83	0	82 c
60	84	150	84 b
120	85	300	85 ab
180	85	450	86 a
CV (%)	3.47		2.85
LSD (0.05)	NS		*

Impact of salt stress on the germination of maize seeds and seedling

This investigation was done to find out germination response of 24 maize (*Zea mays* L.) genotypes. Germination tests were carried out with two levels of salt concentrations (0 dSm^{-1} and 12 dSm^{-1}) in plastic tray under quartz granules. Each tray contained 100 seeds with four replications and each replication bear 25 seeds. Analysis of variance (ANOVA) indicated that all traits significance ($P<0.01$) for genotypes, treatment and their interaction. Germination percentage (GP), germination speed (GS),germination index (GI), total dry matter (TDM), seed vigor index (SVI) and salt tolerance index (STI) were all decreased as the level of NaCl was increased. Mean germination time (MGT) a number of seminal root were increased as the NaCl levels increased. Interaction between genotypes and salt levels showed varying degree of differences. It is concluded that genotypes showed response variability for seed germination under saline stress. Among the investigated genotypes hybrids PAC-293, C-6485, Moni-mukta, 942, 900M, PAC339, Kaveri and PAC-999 expressed as the tolerant genotype and 981 appeared to be more sensitive at germination stage.

Seed yield and quality of garden pea as influenced by phosphorus level and mycorrhizal association

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Joydebpur, Gazipur, during rabi season of 2016-17 to find out the optimum phosphorus level and mycorrhizal association for quality seed production of garden pea. The experiment was laid out in a split plot design where two mycorrhizal treatments viz., M_0= Without mycorrhiza and M_1= With mycorrhizawas assigned in main plot and four levels of phosphorus (P) viz., P_0=0 kg/ha P (control), P_{20}= 20 kg/ha P, P_{40}=40 kg/ha P and P_{60} =60 kg/ha P in the form of TSP was assigned in subplot. Cowdung @ 10 t/ha and NPKSB @ 40, 30, 12,1.5 and 1.0 were applied as general dose. The garden pea variety was BARI Motorshuti-3. Seeds were sown on 28 November 2016 in 40 cm row spacing. The crop was harvested at 15 February 2017. Plant height, dry matter production at harvest, number of pod $plant^{-1}$ and seed yield was significant under different level of phosphorus fertilizer. After seed germination, root length, shoot length, seedling dry weight and seed vigour index were significant under different level of phosphorus fertilizer and mycorrhiza. Plant height, pod no per plant, pod length, seed per pod and seed yield was found maximum when 40 kg/ha P was used (Table 1). Maximum seed germination rate was found from P_{20} kg/ha treatment, but highest root length, shoot length was found from P_{40} kg/ha treatment. Seedling dry weight and finally seed vigour index was recorded from P_{20} treatment. From the study it was observed that 40 kg/ha phosphorus with mycorrhiza performed better regarding seed yield, but 20 kg/ha phosphorus with mycorrhizashowed superior performanceregarding seed quality parameters of garden pea.

Table 1. Interactioneffect of phosphorus fertilizer and mycorrhizal association on yield attributes of garden pea

Treatments	Plant height (cm)	Dry matter/plant (g)	Pod/plant (no.)	Pod length (cm)	Seed/ pod (no.)	100- seed weight (g)	Seed yield (kg/ha)
M_0P_0	34.83c	5.47b	5.37e	5.02 b	4.56b	25.17a	929.7 d
M_0P_{20}	39.98bc	7.27ab	8.11cd	5.84 a	5.13ab	25.89a	1078.3 bcd
M_0P_{40}	43.58ab	8.25ab	9.72ab	6.01 a	5.38a	26.21a	1163.3bc
M_0P_{60}	42.59ab	6.90ab	8.37cd	6.15 a	5.17ab	25.65a	1159.3bc
M_1P_0	35.41c	5.71 b	6.39d	6.22 a	4.88ab	25.56a	1054.7 cd
M_1P_{20}	39.58ab	9.31a	8.68bc	6.31 a	5.34a	25.41a	1378.3 a
M_1P_{40}	45.61a	7.97ab	10.56a	6.44 a	5.57a	26.25a	1388.7 a
M_1P_{60}	43.05ab	6.13ab	8.69bc	5.77 a	5.15ab	25.77a	1243.3 ab
CV (%)	9.50	17.86	7.98	7.81	7.46	4.53	18.20

N.B.: M_0 = No Mycorrhiza,M_1= With Mycorrhiza, P_0= 0 kg P (Control), P_{20} = 20 kg P,P_{40}= 40 kg P, P_{60}= 60kg P

Table 2. Interactioneffect of phosphorus fertilizer and mycorrhiza on seed quality of garden pea

Treatments	Germination (%)	Root length(cm)	Shoot length(cm)	Individual seedling dry weight(mg)	Vigour index
M_0P_0	84 ab	9.24 b	10.15b	125.07 d	3660.4 d
M_0P_{20}	84.33 ab	12.86ab	10.24 b	137.80 cd	4861.2 c
M_0P_{40}	87 ab	13.14ab	11.48b	181.0 ab	6622.7 a
M_0P_{60}	81.67 ab	13.11ab	10.42 b	167.4 b	5388.6 bc
M_1P_0	84.00 ab	13.15ab	10.84ab	169.73 b	5255.5 bc
M_1P_{20}	93.33 a	14.54 a	12.23a	194.60 a	7261.7 a
M_1P_{40}	78.67b	13.84 a	11.61ab	183.40 ab	6625.0 a
M_1P_{60}	77.67b	13.12ab	10.99ab	170.7 b	5709.9 b
CV (%)	8.82	17.09	8.08	6.19	22.64

N.B.:M_0 = No Mycorrhiza, M_1= With Mycorrhiza, P_0= 0 kg P (Control), P_{20} = 20 kg P,P_{40}= 40 kg P, P_{60}= 60kg P

Effect of date of sowing on quality seed production of onion

The experiment was conducted at the research field of Seed Technology Division, BARI, Joydebpur, Gazipur, during the period from October 2016 to March 2017 to find out the optimum planting time to achieving higher seed yields and seed quality of onion under the changing agro-climatic conditions of Bangladesh. The experiment was laid out in a Randomized Complete Block Design with three replications. Treatments comprises of five planting time viz. P_1: 01 Octoberber, P_2: 10 October, P_3: 20 October, P_4:30 October and P5: 10 Nov. 2016.BARI Piaj-1 was used as test variety. Cowdung @5t/ha and NPKSZnB @ 110, 44, 75, 20, 2 and 1.5 kg/ha, respectively were used in the field. Onion bulbs were planted as per treatment maintaining a spacing of 20 cm X 15 cm. Number of umbel m^{-2}, fruit $umbel^{-1}$ and seed yield was found significant due to different time of planting. The highest no of umbel m^{-2} was found from 10 November sowing and the lowest was from 01 October sowing. Fruit $umbel^{-1}$was recorded maximum from 20 October sowing. The highest seed yield was obtained from 30 October sowing and it was statistically similar with 10 November sowing (Table 1). In case of seed quality parameters, the germination per cent, root length, shoot length and seedling vigor index were non-significant due to different time of planting but seedling dry weight was significant due to the treatment effect (Table 2). Therefore, planting onion at 30 October was suitable for higher seed yield with better quality.

Table 1. Yield and yield attributes of onion as affected by different sowing dates

Treatments	Umbel /m^2 (no.)	Fruit/ umbel (no.)	Seed/ fruit (no.)	Yield/plant (g)	1000-SW (g)	Seed yield (kg/ha)
01 October	4.36 c	254.47 b	3.83 a	2.69 b	3.49 a	77.88 c
10 October	6.50 c	268.47 b	4.31 a	3.08 a	3.40 ab	124.48 c
20 October	25.43 b	353.67 a	4.71 a	3.71 a	3.31 ab	539.56 b
30 October	54.04 a	242.80 b	3.79 a	2.43 b	3.44 ab	794.43 a
10 November	56.59 a	235.13 b	4.04 a	2.48 b	3.23 b	744.62 a
CV (%)	9.21	12.57	12.58	14.77	3.78	15.14

Table 2. Seed quality parameters of onion as affected by sowing dates

Treatments	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling dry wt. (mg)	Seed vigor Index
01 October	85.33 a	4.31 a	5.81 a	2.54 a	222.83 a
10 October	84.00 a	4.44 a	5.96 a	2.60 a	218.20 a
20 October	79.33 a	4.40 a	5.42 a	2.62 a	207.51 ab
30 October	79.33 a	4.43 a	5.79 a	2.55 a	202.29 ab
10 November	84.00 a	3.78 a	5.52 a	2.11 b	173.55 b
CV (%)	7.06	11.80	12.27	7.50	10.16

Seed development pattern of garden pea

The experiment was conducted at the research field of Seed Technology Division, BARI, Joydebpur, Gazipur, during the period from November 2016 to March 2017 to find out the grain growth pattern and harvest maturity period of garden pea of BARI Motorshuti-3. For studying seed development pattern, one thousand flowers were tagged observing start of anthesis and five days interval data was recorded starting from anthesis up to harvest (45 DAA). Pod length was increasing rapidly up to 15 DAA and then increasing slowly. Seed (ovule) per pod was highest at initial stage but before seed setting it was decreasing. After 15 DAA the seed no. per pod was statistically same up to harvest. Seed moisture content and dry matter of seed were significant due of different dates of harvest. Grain dry matter increase gradually up to 15 DAA and then rapid up to 35 DAA and then quite steady after 40DAA. Single seed dry weight was increasing after anthesis and maximum was found from the seed of 40DAA and it was statistically same with 45 DAA (Table 1). Seed quality was varied due to different time of seed harvest after anthesis. Seed germination was recorded maximum at 40 DAA which was identical with 40 DAA (Table 2). Statistically the highest root length (13.25 cm) and highest shoot length (9.97 cm) was recorded from 40 DAA. Individual seedling dry weight was found maximum (106.94 mg) from the seed of 40 DAA and it was statistically identical with 45 DAA. Seed vigor index was maximum (7652) from the seed of 40 DAA although it was statistically similar with 45 DAA. Therefore, garden pea pod should be harvested at 40 to 45 days after anthesis for better seed quality.

Table 1. Seed development pattern of garden pea at different harvests

Treatments	Pod length(cm)	Seed/pod (no.)	Moisture (%)	Dry Matter (%)	Individual seed dry wt. (g)
0 DAA	0.87g	8.87a	-	-	-
5 DAA	3.45f	8.00ab	91.33 a	8.67h	0.0016e
10 DAA	5.40e	7.43bc	86.84 a	13.16h	0.0175e
15 DAA	7.19d	7.33cd	83.23b	16.77g	0.0212e
20 DAA	7.31cd	7.00 cd	81.22c	18.78f	0.0841d
25 DAA	7.35bcd	6.96 d	75.81d	24.19e	0.1226 c
30 DAA	7.53abcd	6.90d	62.14e	37.86d	0.1504 b
35DAA	7.61abc	6.80 d	49.59f	50.41c	0.2026a
40DAA	7.68ab	6.46d	43.11g	56.89b	0.2561a
45DAA	7.66a	6.33d	37.64h	62.36a	0.2537a
CV (%)	3.31	5.46	4.40	9.29	12.30

Table 2. Seed quality parameter of garden pea at different time of harvest

Treatments	Germination (%)	Root length(cm)	Shoot length(cm)	Seedling dry weight (mg)	Vigour index
0 DAA	0.00	0.00	0.00	0.00	0000
5 DAA	0.00	0.00	0.00	0.00	0000
10 DAA	0.00	0.00	0.00	0.00	0000
15 DAA	0.00	0.00	0.00	0.00	0000
20 DAA	33.67d	3.08 d	4.52d	37.46d	1268 e
25 DAA	44.67c	6.30 c	5.41c	44.80cd	1994 d
30 DAA	50.67b	8.34 c	7.91c	51.48 c	2611 c
35 DAA	60.67a	11.57 b	9.28b	91.14 b	5565 b
40 DAA	81.00a	13.25a	9.97a	106.94 a	7652 a
45 DAA	76.67a	12.40a	9.24a	103.52a	6943 a
CV (%)	10.76	15.48	9.16	15.05	19.08

Integrated weed management in summer mungbean for quality seed production

The field experiment was carried out at the research field of Seed Technology Division Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during kharif-I season of 2017 to study the effect of different weed management practices and its effect on yield attributes and seed quality of mungbean. The weed management practices were:T_1= No weeding (control), T_2= Glyphosate spraying at one week before sowing, T_3= Whip super spraying at 2 to 4 leaf stage of weed, T_4=Spading between the rows at 20 days after sowing (DAS), T_5= Hand hoeing at 20 DAS, T_6=T_2+T_5, T_7= T_3+T_5, T_8= Weed free. In case of weed free plot, weeding was done at 10 days interval for four times. Mungbean variety was BARI Mung-6. The crop was fertilized with NPK @20, 40 and respectively in the form of urea, triple super phosphate and muriate of potash. Seeds were sown on March 21, 2017 maintaining a row spacing of 30 cm. Weed biomass were significantly influenced by different management practices. At harvest the lowest weed biomass (5.5 g m^{-2}) were obtained from T_8 treatment and the highest (1149.3 g m^{-2}) weed biomass were found from T_1 treatment (Table 1). Seed yield was recorded maximum (1870.0 kg /ha^{-1}) from T_8 treatment and the lowest seed yield (378.3 kg ha^{-1}) was found from control plot (T_1) (Table 2). After harvest the seed germination rate was found maximum (83%) from T_8 treatment and it was statistically identical with T_6 and T_7 treatment (Table 3). Significantly the lowest seed germination rate (40%) was recorded from T_4 treatment and it was statistically similar with control (T_1) treatment. Root length and shoot length of the tested seed were found maximum from T_8 treatment and minimum were recorded from control (T_1) treatment. The highest seed vigor index (2468) was recorded from T_8 treatment and it was statistically similar with T_6 and T_7 treatments (Table 3). Ten weed species were observed in the summer mungbean field (Table 4).

Table 1. Weed biomass (g m^{-2}) as affected by different weed management practices

Treatments	20 DAS	35 DAS	45 DAS	55 DAS	65 DAS	Weed control efficiency (at 65 DAS)
T_1	15.29b	243.28 a	444.93 a	853.07 a	923.04 a	-
T_2	2.71a	45.61 de	186.59 c	538.92 b	562.99 c	39.01
T_3	10.76b	152.87 b	368.38 b	539.09 b	676.16 b	26.75
T_4	19.28b	116.62 bcd	120.82 d	553.39 b	557.12 c	39.64
T_5	19.76b	94.84 bcd	204.95 c	384.85 c	392.99de	57.42
T_6	1.22a	13.83e	86.93 e	168.69 d	172.08g	81.35
T_7	15.86b	44.96 de	126.62 d	144.69 e	304.53ef	67.01
T_8	1.68a	3.38 e	3.85 f	5.08 g	5.92h	99.35
CV (%)	14.04	14.29	9.29	16.99	11.53	-

T_1= control, T_2=Glyphosate spraying at one week before sowing, T_3= Whip super spraying at 2 to 4 leaf stage of weed, T_4=Spading between the rows at 20 days after sowing (DAS) , T_5= Hand hoeing at 20 DAS, T_6=T_2+T_5, T_7= T_3+T_5, T_8= Weed free.

Table 2. Yield and yield attributes of mungbean as affected by different weed management practices

Treatments	Plant height (cm)	pod /plant (no.)	Pod length (cm)	Seed./ pod (no.)	TSW (g)	Seed Yield (kg/ha)	Yield increase over control
T_1	43.9e	8.24de	7.06d	3.31g	36.36 c	378.3 e	00
T_2	51.91cd	9.14 de	7.56 cd	4.64 f	38.16 c	1071.7 cd	183%
T_3	48.29de	5.76eff	7.43 cd	4.28 f	44.65ab	600.0 de	59%
T_4	52.56 cd	10.25d	7.75 bc	5.43 e	43.91 b	1226.7 bc	224%
T_5	57.05bc	11.21d	8.08 bc	5.99 d	45.35 ab	1353.3 bc	258%
T_6	63.59 ab	16.86 b	8.98 a	8.49 b	45.95ab	1573.3 ab	316%
T_7	61.56 ab	12.72 c	8.30 b	7.28 c	44.35 ab	1456.7 abc	285%
T_8	62.57 ab	20.81a	9.23 a	9.20 a	47.90 a	1870 a	394%
CV (%)	7.04	11.52	4.63	4.42	5.07	22.82	-

T_1= control, T_2=Glyphosate spraying on one week before sowing T_3= Whip super spraying at 2 to 4 leaf stage of weed, T_4=Spading between the rows at 20 days after sowing (DAS), T_5= Hand hoeing at 20 DAS, T_6=T_2+T_5, T_7= T_3+T_5, T_8= Weed free

Table 3. Seed quality parameters of mungbean as affected by different weed management practices

Treatments	Germination %	Root length (cm)	Shoot length (cm)	Seedling dry weight (mg)	Seed Vigor Index
T_1	28 e	2.31 d	9.50 e	16.62 e	455.4 f
T_2	41.3 de	3.32 c	11.30 abcd	21.86c	903.6 de
T_3	36.0 e	3.03 cd	10.30 de	19.11d	683.0 ef
T_4	55.3 bc	2.7 0 d	10.88 bcde	20.31cd	1128.2 bcd
T_5	52.0 cd	2.8 2 cd	10.52 cde	19.79d	1031.8 cde
T_6	77.3 ab	3.38 bc	12.08 abc	21.88c	1455.4 ab
T_7	58.0 bc	4.23 ab	12.43 ab	22.89b	1305.5 bc
T_8	80.6 a	4.64 a	12.65 a	24.75a	1812.7 a
CV (%)	15.20	15.61	8.29	8.28	15.49

N.B :T_1= control, T_2=Glyphosate spraying on one week before sowing T_3= Whip super spraying at 2 to 4 leaf stage of weed, T_4=Spading between the rows at 20 days after sowing (DAS) , T_5= Hand hoeing at 20 DAS, T_6=T_2+T_5, T_7= T_3+T_5, T_8= Weed free

Table 4. Common weed species in the experimental mungbean field

Common Name	**Scientific Name**
Shyma	*Echinochloacrusgalli*
Anguli	*Digitariasangunalis*
Hatishur	*Heliotropiumindicum*
Maloncha	*Alternantherasp*
Gaicha	*Paspalumcommersoni*
Mutha	*Cyperusrotundus*
Durba	*Cynodondactylon*
Fulka	*Leptochloachinensis*
Shaknotey	*Amaranthusviridis*
Chapra	*Elusineindica*

Effect of storage conditions on seed quality of capsicum

The study was conducted at Seed Technology Division, BARI, Joydebpur, Gazipur, during 2016-17, to find out suitable storage condition of capsicum for maintaining seed quality. Germination percentage, seedling vigour index and electrical conductivity were studied in this study. Germination percentage and vigour index were increased with increasing of storage time up to three month in ambient condition, cool room, normal fridge and deep fridge. The deceasing rate was higher when seeds kept in ambient condition. However, in terms of electrical conductivity test were still lower up to nine month then it was increased in all storage condition.

Yield and quality of garden pea as influenced by sowing dates and varieties

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during rabi season of 2016-17 to find out the effect of sowing dates and varieties on yield and quality of garden pea seed**.** Garden Pea seeds of two varieties viz., BARI Motorshuti-1 and BARI Motorshuti-3 were sown at 10 days interval from 20 October to 30 November. Seeds were sown with a spacing of 40 cm X 10 cm. Significantly higher seed yield (1.70 t/ha) was found in 20 November sowing date followed by 30 November sowing date. Among the varieties, BARI Motorshuti-1 produced significantly higher seed yield compared to BARI Motorshuti-3. Maximum seed yield 1.90 t/ha was noted on 20 November sowing of BARI Motorshuti-1 (Table 1). BARI Motorshuti-3 at 20 November showed better seed quality in terms of germination and vigor index.

Table 1. Interaction effect of sowing dates and varieties on contributing characters, seed yield and quality of garden pea

Treat ment	Pods/ plant (no.)	Seeds/ pod (no.)	100 seed weight (g)	Seed yield (t/ha)	Germination (%)	Individual Seedling dry weight (mg)	Vigor index
V_1D_1	7.80 de	3.20 de	15.73 cd	0.95 d	74.66 c	28.66 e	2146 e
V_1D_2	11.60 bcd	3.50 cde	14.98 d	1.00 d	85.33 ab	31.33 cde	2673 cde
V_1D_3	15.20 b	4.73 bc	16.68 bcd	1.33 bc	86.66 ab	36.66 abc	3186 bc
V_1D_4	22.46 a	5.73 b ab	17.62 bcd	1.90 a	90.66 a	38.66 ab	3485 ab
V_1D_5	13.66 bc	4.06 cd	15.25 d	1.60 ab	80.00 bc	33.66 bcde	2692 cde
V_2D_1	4.13 e	2.16 e	15.12 d	0.15 e	76.00 c	30.00 de	2292 de
V_2D_2	4.20 e	2.76 de	15.50 d	0.18 e	85.33 ab	32.33 cde	2752 cd
V_2D_3	5.53 e	5.86 b	18.96 bc	0.47 e	90.66 a	39.33 ab	3568 ab
V_2D_4	8.33 cde	9.26 a	22.89 a	1.51 b	92.00 a	42.00 a	3854 a
V_2D_5	4.86 e	3.53 cde	19.112 b	1.13 cd	86.66 ab	36.00 abcd	3118 bc
CV (%)	32.10	18.21	11.37	18.33	5.50	10.10	11.64

In a column, values with same letter (s) do not differ significantly at 5% level of probability

Where, Sowing dates**:** i) D_1= 20 October, ii) D_2 = 30 October, iii) D_3= 10 November, iv) D_4 = 20 November v) D_5 = 30 November and varieties**:** i) V_1= BARI Motorshuti-1 and ii) V_2 = BARI Motorshuti-3

Effect of major nutrients and picking stages on seed yield and quality of french bean

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during rabi season of 2016-17 to study the effect of nutrients and picking stages on seed yield and quality of French bean. There were 12 treatment combinations of three fertilizer levels (F1-120:20:10NPK kg/ha, F2-140:30:25NPK kg/ha and F3-160:40:40NPK kg/ha) and four picking stages (P_1- Picking at 75 DAE, P_2- Picking at 80 DAE, P_3- Picking at 85 DAE and P_4- Picking at 90 DAE). Seeds were sown with a spacing of 30 cm $\times$15 cm. Urea, TSP, MP, Gypsum and Boric acid were used as a sources of N, P, K, S and B respectively. The results indicated that the fertilizer level of

160:40:40 (NPK Kg/ha) noticed significantly higher plant height (48.40 cm), number of pods per plant (20.11), number of seeds per pod (5.75), and seed yield (1.14 t/ha) (Table 1). Better seed quality parameter such as 100 seed weight (26.71 g), germination percentage (84.33 %), seedling vigour index (1567), seedling dry weight (185.25mg) were noticed (Table 2). Among the different picking stages, 75 DAE recorded significantly higher pod yield per plant (41.92g) and seed yield per ha (0.96 t/ha) along with seed quality parameters viz., 100 seed weight (25.21g), germination (89.77 %), seedling dry weight (180.33mg) and seedling vigour index (16231).

Table 1. Interaction effect of major nutrients and picking stages on seed yield parameter of French

Treatments	Plant height(cm)	Number of pods/ plant	Seeds/ pod (no.)	Pod yield per plant(g)	Seed yield(t/ha)
$F_1\times P_1$	48.77 ab	16.93 ef	5.56 ab	35.20 de	0.74 def
$F_1\times P_2$	45.94 de	16.40 fg	5.43 abc	33.43 e	0.61 ef
$F_1\times P_3$	44.25 ef	14.86 gh	5.33 abc	28.51 fg	0.58 f
$F_1\times P_4$	43.76 f	13.33 h	5.03 c	24.61 g	0.55 f
$F_2\times P_1$	49.94 a	19.40 bcd	5.76 a	42.07 c	0.87 cd
$F_2\times P_2$	46.23 d	18.73 cde	5.66 ab	37.58 d	0.86 cd
$F_2\times P_3$	46.77 cd	18.20 cdef	5.43 abc	36.10 de	0.77 de
$F_2\times P_4$	46.23 d	17.60 def	5.26 bc	32.31 ef	0.60 ef
$F_3\times P_1$	50.41 a	21.33 a	5.80 a	48.50 a	1.27 a
$F_3\times P_2$	47.69 bcd	20.60 ab	5.56 ab	47.53 ab	1.15 ab
$F_3\times P_3$	48.61 abc	19.86 abc	5.66 ab	46.65 ab	1.08 ab
$F_3\times P_4$	47.36 bcd	18.66 cde	5.23 bc	43.79 bc	1.05 bc
CV (%)	2.37	6.11	5.34	6.22	13.67

F_1- 120:20:10 kg/ha NPK, F_2-140:30:25 kg/ha NPK, F_3-160:40:40 kg/ha and P_1-75 DAE, P_2-80 DAE, P_3-85 DAE, P_4-90 DAE

Table 2. Interaction effect of major nutrients and picking stages on seed quality parameter of French bean

Treatments	Germination (%)	100 seed weight(g)	Seedling dry weight (mg)	Vigor index
$F_1\times P_1$	85.33 cd	22.26 cd	169.33 de	14459 de
$F_1\times P_2$	78.66 ef	21.76 d	157.33 fg	12365 fg
$F_1\times P_3$	74.66 fg	21.03 d	150.33 gh	11215 h
$F_1\times P_4$	70.66 g	21.01 d	135.33 i	9563 i
$F_2\times P_1$	90.66 ab	23.55 c	174.67 cd	15847 bc
$F_2\times P_2$	82.66 cde	22.71 cd	162.67 ef	13413 ef
$F_2\times P_3$	78.66 ef	22.11 cd	157.00 fg	12332 g
$F_2\times P_4$	76.00 f	21.57 d	146.33 h	11120 h
$F_3\times P_1$	93.33 a	29.82 a	197.00 a	18387 a
$F_3\times P_2$	86.66 bc	26.88 b	187.33 b	16224 b
$F_3\times P_3$	81.33 de	26.34 b	183.67 bc	14851 cd
$F_3\times P_4$	76.00 f	23.80 c	174.00 d	13208 fg
CV (%)	3.63	4.35	2.90	4.64

F_1- 120:20:10 kg/ha NPK, F_2-140:30:25 kg/ha NPK, F_3-160:40:40 kg/ha and P_1-75 DAE, P_2-80 DAE, P_3-85 DAE, P_4-90 DAE.

Modification of carbohydrate profile to increase the acceptance and efficacy of zinc phosphide baits against field rat

The experiment was conducted in the wheat crop of BARI research field, Joydebpur, Gazipur during 2016-17 to increase the acceptance and efficacy of zinc phosphide baits against field rat. Three new formulation of zinc phosphide poison bait viz. formulation 1, 2 and 3 was developed by mixing zinc phosphide poison (80% a.i.) with wheat grain + sugar + barley, wheat grain + sugar + dry fish + barley and wheat grain + sugar + dry fish + powder milk + barley respectively and their consumption and rodent control efficacy were tested against field rat, *Bandicota bengalensis.* The rat consumed a significantly higher amount of the newly formulated zinc phosphide bait than the traditional formulated bait. Present study indicated that changing the carbohydrate profile that means increasing sugar in zinc phosphide poison bait formulation increased consumption by rat and also increased its rodent control efficacy.

Survey on flying fox damage in litchi orchard in litchi growing area

A questionnaire survey on flying fox (fruit bat) problem was conducted among the litchi farmers of Dinajpur and Rajshahi district during 2016-17. Among the 80 farmers, 40% farmers had about 30 trees and only 18.75% farmers had more than 90 trees. Maximum farmers cultivated popular litchi variety viz. Bombai, China-3, Madrazi and Bedena. According to the farmers (86.25%), flying fox damage occurred at mature stage of litchi when it turns in to reddish colour. Flying fox cause damage at early night in litchi orchard. Flying fox caused fruit damage by chewing and sucking followed by dropping. Average loss per farmers was reported to be Tk. 6135.76 per year. Most popular control method to the farmers was netting (76.25%) followed by scaring (20.00%).

Development of suitable bird repellent (sub-lethal dose) for repelling bird in sprouting wheat in laboratory

The experiment was conducted at the aviary of Vertebrate Pest Division, BARI, Gazipur to repel birds from sprouting wheat using repellent techniques. One chemical repellent Hadak (Imidacloprid + Thiram) was evaluated as bird repellents in caged feeding trials. Blue rock pigeons were used as test birds. The bird was caged individually provided food and water *ad libitum.* Individual cage feeding trials were conducted in an aviary, where individual cages (45x30x40 cm3) were visually isolated and equipped with water. Food was supplied in plastic food cups with a circular opening in the top. Four days before starting the trial, we removed birds from their holding cages, weighed them, and randomly assigned each to a test cage. Test groups of 5 birds each were formed by randomly assigning birds to receive either untreated wheat treated with Hadak 0.4%. During the 4-day acclimatization period, we provided birds with a mixture of seed diet. Following acclimatization, there was a 4-day pretreatment period, and a 4-day treatment period. During pretreatment, each bird's offered 20 g of untreated wheat seed. In the treatment phase, birds received treated 20g wheat and 20g untreated wheat. Aluminum trays suspended from test cages under each cup caught spillage. The spillage information was used to estimate the proportion of wheat seed removed from the cups that was actually eaten. Cups containing test food not exposed to birds were put in vacant cages to determine mass changes due to moisture. After 7 h, test food was removed and the birds' maintenance food again provided. Contents of test food cups were weighed and consumption determined by subtraction after appropriate adjustments for spillage and moisture gain. We randomized the positioning of treatments within individual cages on the first day and alternated positioning on subsequent days of the test to overcome potential side preferences. After the final treatment day, test birds were reweighed and released. The bird that had consumed ≥ 50% of the amount offered was considered repelled.

For repellents tested, blue rock pigeon discriminated between untreated and treated wheat during preference testing. It was observed that less consumption of wheat treated with Hadak than that of untreated wheat during the four-day test periods. On average, blue rock pigeons consumed 9.95 (±0.73) g per bird per day of untreated wheat and 1.86 (±0.76) g per bird per day of wheat treated with Hadak. The consumption of Hadak treated seed was significantly lower than the untreated bait (t=14.305 p=0.00). The average acceptance of Hadak treated and untreated seed was 9.75% and 49.76 % respectively. In repellency test Hadak exhibited the better repellency (40%) than untreated seed.

Survey on bird damage in sprouting wheat in different wheat growing areas of Bangladesh

The study was conducted in the wheat growing areas of Rajshahi region during 2016-17 planned to know the extent of damage by bird in sprouting wheat. The Questionnaire survey was conducted in four upazila, Viz., Charghat, Godagari, Durgapur and Putia of Rajshahi disrict. Questionnaire survey on bird damage in sprouting wheat in farmer's field was conducted among randomly selected 15 farmers from each upazilla. Scientists of Vertebrate Pest Division took the framers interview with a prescribed questionnaire sheet. It included different questions such as size of farm, damage caused by bird species in sprouting wheat, intensity of bird damage, nature of damage, stage of damage, damage time of the day, problem of bird in ripening stage and different control methods used by the farmers etc. This survey was conducted at the time of sowing season of wheat during 2016. The farmers who actually worked in the farms during these seasons are selected for the questionnaire. It is also an important tool for understanding the extent of awareness about birds as part of the agro eco-system and learning the traditional and modern techniques used by farmers and works in order to avoid the loss and to know their effectiveness.

From the study it was revealed that birds were the major problems in sprouting wheat. Many birds caused damage to sprouting wheat such as common myna, pied myna, house crow, jungle crow, pigeon, hen, duck etc. 100% farmers opined that Pied myna, common myna, crow are the most serious pests in sprouting wheat. Maximum bird damage occurs between 10-15 days of seeding and damage ranges from 20–50 percent. Birds also a problem in ripening stage of wheat. Farmers use different control techniques for controlling bird and common techniques are scaring and repelling.

Use of reflective ribbon as a pest bird's repellant in broccoli

The study was carried out in the research field of Plant Genetic Resources Centre (PGRC) field, BARI during 2016-2017 for repelling bird using reflective ribbon. For the study multicolored reflective ribbons were used as mechanical repellant against pests' bird. The broccoli plots measuring 20m x 3m were selected to install the reflective ribbons as pest bird's repellent. The study was laid out following RCBD design with three dispersed replications. Variety was BARI Broccoli-1 and the treatments were multicolored ribbon and control (without ribbon). Broccoli was planted on 25th November, 2016 maintaining spacing 60cm x 50cm and fertilizer dose was urea 260 kg/ha, TSP 150 Kg/ha, MoP 100kg/ha and gypsum 80 kg/ha of land. Reflective ribbons were tied up over the crops longitudinally supported by bamboo sticks and plastic rope. Height of the reflective ribbons was given special consideration because too high and too low reflective ribbon had significant effect on visiting bird pests. The reflective ribbon erected about two feet above the crop canopy was found to give better results. Number of pest birds (red vented bulbul) visiting the research fields of broccoli during the use of Reflective ribbon (mechanical repellents) was counted.

The results showed that the maximum number of birds were visited on control plot where ribbon was not used and minimum were recorded in multicolored ribbon treated plots. Percent bird damage caused by bulbul was also recorded and it was lower in multicolored ribbon treated plots compared to control treatment. Average curd weight was also higher in multicolored reflecting treated plots (490 g/plant) than the control (350 g/plant) plots. Higher yield (6.53t/ha) of broccoli was obtained from multicolored treated plots while from control plot it was 4.46 (t/ha).

Survey on squirrel damage in different fruits and vegetables in selected areas of Bangladesh

A study was conducted on squirrel problem in different crops to understand the status of squirrel as a pest, their damage severity, to gain some basic knowledge among the farmers in Chittagong and Jessore districts of Bangladesh during 2016-17. One upazilla of Chittagong and one upazilla of Jessore were selected for this study. The questionnaire survey was conducted in three villages from Hathazari upazilla of Chittagong and three villages from sadar upazila of Jessore disrict. Questionnaire survey on squirrel damage in fruit and vegetables was conducted in fruit and vegetables growing farmers. The study was conducted among randomly selected 32 farmers from Hathazari upazilla, Chittagong and 30 farmers from sadar upazilla of Jessore district. Scientists of Vertebrate Pest Division took the framers interview with a prescribed questionnaire sheet. It included different questions such as on species composition, crops damaged by the squirrels, intensity of damage, amount of loss, breeding season, number of parturition per year, control method used by the farmers etc. The farmers who actually worked in the farms during these seasons were selected for the questionnaire. It is also an important tool for understanding the extent of awareness about squirrel as part of the agro eco-system.

From the study it was observed that sixty percent farmers reported one species and 37% farmers reported two species of squirrels. According to the farmer’s opinion, vegetables, cereals and fruit crops are frequently damaged by the squirrels. It causes severe damage to rice (32.25%), wheat (24.19%) and maize (27.41%). Most affected vegetable crops are brinjal (46.77%), pumpkin (16.12%) bottle gourd (12.9%) and potato (8.06%). Among the fruit crops maximum damage was found in coconut (74.19%) followed by mango (50.0%), Guava (46.77%) and Ber (32.25%). Average loss per farmer was reported to be Tk. 1000-2000 per year. Maximum damage was occurred at all stage (51.16%) of the crop in all the season (35.48%). Farmers were not sure about the breeding frequency (80%), breeding season (80%) and number of young per parturition (82.25%). Parturition usually took place in the nest on the branches of trees (11.29%). Most popular control method used by the farmers was poison baiting (20.96%) followed by trapping (14.51%) and shooting (9.67%).

Efficacy of newly designed Gopher gophinator trap for controlling burrowing rats

Comparative efficacy of newly designed Gopher gophinator trap and Snap trap for controlling rodents was evaluated in vertebrate pest division, BARI, Gazipur and sadar Upazilla of Gazipur and Dinajpur districts during the period of July, 2016 to May, 2017. The efficacy of Snap kill trap was better than the Gopher gophinator trap in both enclosure and field-test. In the field, the average success of Snap trap was 27.14% while Gopher gophinator trap showed no success (0.00%). Similarly, at enclosure of Vertebrate Pest Division the success of Snap kill trap was 38.57% but it was 0.00% in Gopher gophinator trap. Due to some difficulties in manufacturing, no rats were captured in newly designed Gopher gophinator trap. Therefore, some modification should be needed to improve the newly designed Gopher gophinator trap for trapping rats successfully.

Effect of chitosan coating on the quality and shelf life of papaya

Fresh matured papaya fruits at the pre climacteric stage (nearly ripe) with green color were collected from the farmer's field of Pabna district and some fruits were randomly selected for the experiment. The papaya were transported to the Postharvest Technology Division Laboratory of BARI, Gazipur in plastic crates, where it were sorted out to remove immature, misshaped, bruised, diseased and insect infested. The papaya was then washed, air-dried and treated with different percentages of chitosan solution.

Sample Treatment

Chitosan solutions were prepared by dissolving 0.5, 1.0, 1.5 and 2.0 g of chitosan in 100 ml distilled water containing 0.5 ml (v/v) of glacial acetic acid. The solution was heated and agitated constantly for 2 h. The p^H of the solution was adjusted to 5.6 with 1 N NaOH . The papaya fruit was washed with chlorinated water (0.01%), prepared from 5% sodium hypochlorite, prior to coating treatments. The samples were allowed to air dry, after which they were randomly divided into five different treatments. Followed by drying, the papaya fruits were dipped into different concentrations of chitosan for 1 min along with untreated control sample. The papayas were then air dried, kept in plastic shelf and stored at ambient condition. The treatments were solution of chitosan T_1 = Control, T_2 = 0.5% aqueous solution of chitosan, T_3 = 1.0% aqueous solution of chitosan, T_4 = 1.5% aqueous solution of chitosan
T_5 = 2.0% aqueous solution of chitosan.

Standardization of sweet potato powder for soup

The study was conducted in the laboratory of the Postharvest Technology Division of BARI, Gazipur. Orange fleshed fresh sweet potatoes (*Ipomoea batatas*) were collected from Tuber Crops Research Centre. Sweet potato roots were sorted out, weighed and washed, knife peeled and cut into 3 mm smaller pieces and immersed into potassium permanganate ($KMnSO_4$) solution for 10 min. Then, drain out the solution and blanching into water bath at 94^0C for 3 minutes. After blanching, cooling was done by tape water and water was removed by sieve. For drying, the sample was spread over the try and kept it into the oven dryer at 70^0C temperature for 48 hrs. After drying, milling the dried sample using high speed micro grinder (speed 25000 rpm). The powder samples were packed into high density polyethylene (HDPE). The treatments consisted of T_1 = without blanched sweet potato powder and T_2 = with blanched sweet potato powder

Standardization of processing method for pineapple juice

The pineapples were procured from the local market. The pineapples were graded, washed, peeled and slice cube. Then, pulp was extracted by blender. After proper blending, the pineapples pulp was screened through a mosquito net cloth and pasteurized at a temperature of 80°C for five minutes. The pasteurized pulp was stored in a deep freeze at a temperature of –20°C for future use.

The juice was prepared maintaining its total soluble solid (TSS) at 12% and P^H of 4.0. The compositions like pulp, sugar, 0.2% CMC (carboxy methyl cellulose), citric acid and water were calculated according to the treatment. The experiment was laid in CRD with two factors. The treatments are T_1 = 15% pineapple pulp (of total juice), T_2 = 25% pineapple pulp (of total juice), T_3 = 35% pineapple pulp (of total juice) and T_4 = 45% pineapple pulp (of total juice)

At first, clean water was boiled at 80^0C for 5 minutes. Then, required sugar was added, dissolved and strained through thick cloth. Then, carboxy methyl cellulose was added, dissolved and heated about 5 to 6 minutes. After that, pulp was added, stirred, mixed thoroughly and heated for 2 minutes. Finally, the prepared juice was strained two times through thick cloth and 600 ppm potassium metabisulphite (KMS) was added. The prepared juice was hot poured into glass container and stored at ambient temperature. The stored samples were analyzed at 15 days intervals for TSS, vitamin C, vitamin A (β-carotene), P^H, acidity, total and reducing sugars as per the method described by Ranganna (1995) to determine its acceptability and keeping quality. Microbial growth (bacteria and fungi) was observed in the stored pineapple juice by the method described by Istavan Kiss (1984) at 15 days intervals by adopting pour plate method using serial dilution technique.

Effect of vapor heat treatment on the postharvest quality of tomato at ambient condition

The experiment was carried out at the Postharvest Technology Laboratory, Postharvest Technology Division, BARI, Joydebpur, Gazipur during 20 February to 8 March, 2017. The experiment was laid out in a Complete Randomized Design (CRD) with three replications. The tomato fruits were collected from Horticultural Research Center, BARI. Three different maturity stages red, turning and matured green of BARI tomato 15 were investigated by applying vapor heat treatment at temperature 55^o C for the durations of 5 minutes. After applying vapor heat treatment 10 fruits in each treatment were kept at ambient storage condition where average temperature was 28^o C and average relative humidity was 75%. Treatment combinations were Red stage + vapor treatment (RV), Turning stage + vapor treatment (TV), Mature green stage + Vapor treatment (MV) and non-treated Red stage (R), Turning stage (T), Mature green stage (M). For comparison and evaluations of treatment combinations different physiological, biochemical and biological parameters were investigated. The data were collected, analyzed statically and the mean differences among the treatments were compared by LSD.

Effect of vapor heat treatment on the postharvest quality of mango at ambient condition

The experiment was carried out at the Postharvest Technology Laboratory, Postharvest Technology Division, BARI, Joydebpur, Gazipur during 5 July to 19 July, 2017. The experiment was laid out in a Complete Randomized Design (CRD) with six replications. The mango fruits were collected from Chapai nowabgonj. Full matured fruits were investigated by applying vapor heat treatment at temperature 55^o C for the durations of 5 and 10 minutes. After applying vapor heat treatment 30 fruits in each replication were kept at ambient storage condition where average temperature was 32^o C and average relative humidity was 79%. For comparison and evaluations of treatment combinations different physiological, biochemical and biological parameters were investigated. The data were collected, analyzed statically and the mean differences among the treatments were compared by LSD.

Effect of heat stress treatment and edible wax coating on improving quality retention of sweet orange (var. Bari Malta 1) during ambient storage

This research experiment was conducted in 2016 by using Postharvest Technology Divisional Lab facility of BARI. Two batches of sweet oranges (BARI Malta 1) were collected from two different locations in two catchment area. First batch of matured green with uniform size (80-90 g, 7.5-8.5% TSS) BARI Malta 1 were harvested in October 2016 from Horticultural Research Center (HRC) orchard, Joydebpur, BARI and 2nd batch of same variety of orange fruit (200-250 g, 6.5-7.5%TSS) were collected from commercial growers' field in Meherpur Sadar in November 2016. The experiment was designed as factorial with/without hot water and with/without wax coating. The best combination of hot water treatment temperature (45^oC) and water immersion time (30 min) and food grade carnauba wax coating evaluated by physiochemical analysis and sensory panelist earlier conducted at another experiment. Three replications (10 fruits/replicate) were considered for each treatment and 15-20 fruit were used for sensory test.

Effect of heat stress treatment and edible wax coating on improving quality retention of pomelo fruit (commercial var.) During ambient storage

This research experiment was conducted in 2016 by using Postharvest Technology Divisional Lab facility of BARI. Two batches of pomelo fruit (commercial variety) were collected from two commercial growers of two different locations of Moulovibazar district. First batch of matured green with uniform size pomelo fruit (400-450 g, 8-9%TSS) were harvested in October 2016 and 2nd batch were in November 2016 (350-400 g, 8-9.5%). The experiment was designed as factorial with/without hot water and with/without wax coating. The best combination of hot water treatment temperature (45°C) and water immersion time (45 min) were estimated to measure internal temperature profile of pomelo fruit. Carnauba wax coating was evaluated by physiochemical analysis and sensory panelist which was earlier conducted at another experiment. Fruit were then sorted and randomly distributed and dipped into hot water at 45°C or ambient water for 45 min used by BARI hot water treatment machine. Three replications (8-10 fruit/replicate) were considered for each treatment to analysis physiochemical parameters, and sensory evaluations as weekly interval up to 3 weeks.

Treated fruit were washed appropriately by required amount of detergent concentration in the PHTD BARI designed and fabricated brush pad for few seconds and then used wax @250 fruit/L on the fruit peel.

Effect of vacuum frying temperature and time on the quality attributes of chips prepared from jackfruit slices

Commercial matured jackfruit obtained from local grower's orchard (Joydebpur, Gazipur, Bangladesh) and was immediately transported to the laboratory for experiment. The jackfruits were washed, peeled, removed the seed from bulb and sliced length wise. The slices of the jackfruits were divided into two groups and only one group were dipped into 80^0C water for 5 minutes. Finally, the jackfruit slices were fried in the vacuum fryer machine at 593.25 mbar vacuum pressure of different time and temperature. After several trials, it was found that the group of jackfruit slices dipped into 80^0C water for 5 minutes performed better quality attributes. Thus, this groups were selected for further experimentation. Treatment combination of the experiment is as follows:

T_1D_1 = 110^0 C frying temperature for 10 minutes,T_1D_2 = 110^0 C frying temperature for 20 minutes, T_1D_3 = 110^0 C frying temperature for 30 minutes, T_2D_1 = 120^0 C frying temperature for 10 minutes, T_2D_2 = 120^0 C frying temperature for 20 minutes, T_2D_3 = 120^0 C frying temperature for 30 minutes, T_3D_1 = 130^0 C frying temperature for 10 minutes, T_3D_2 = 130^0 C frying temperature for 20 minutes, T_3D_3 = 130^0 C frying temperature for 30 minutes.

The fried products were packed in polypropylene (PP) and high density polyethylene (HDPE) packets and stored in ambient temperature. The shelf life and quality of the processed products viz, crispiness, taste, flavor, color and overall acceptance will be evaluated by a taste panel during different storage periods.

Quality retention in litchi by postharvest treatments and modified atmosphere packaging

Commercial matured litchis cv. 'Bomby' obtained from local grower's orchard (Baroya, Joydebpur, Gazipur Bangladesh) and were immediately transported to the laboratory for experiment. Fruits with uniform size and appearance were selected and separated individually from the bunches. Afterwards, the fruits were divided into five groups with 50 fruits in each group.

The treatment combination of experiment is as follows:

T_1 = Control (dipped in water), T_2 = Kept in 0.5% perforated polypropylene, T_3 = 1% carnauba (natural coating material) treated, T_4 = 40 mmol/l ascorbic acid treated, T_5 = Mixed solutions (40 mmol/l AsA + 1% carnauba) treated.

After air drying, each group of fruits were kept in 0.5% perforated polypropylene bag (except the control) and placed in cold chamber at 5°C. The experiment was laid out in complete randomized design with five replications. Data on the changes in different physico-chemical attributes during storage were collected at every four days interval.

Measurements of ascorbic acid, total soluble solids (TSS) and titratable acidity

For ascorbic acid measurement, 10 g pulp tissue was homogenized in 50 mL of 3% cold metaphosphoric acid (HPO_3) using a blender for 2 min and filtered through Whatman filter paper No. 2. The clear supernatant was collected for assaying ascorbic acid by 2,6-dichlorophenolindophenol titration following the method of Ranganna (1986). Ten milliliters of aliquot was titrated with 0.1% 2,6-dichlorophenolindophenol solution until the filtrate changed to pink colour persisted for at least 15 seconds and the titration volume of 2,6-dichlorophenolindophenol was recorded. Prior to titration 2,6-dichlorophenolindophenol solution was calibrated by ascorbic acid standard solution. Ascorbic acid content was calculated according to the titration volume of 2,6-dichlorophenolindophenol and results were expressed as mg 100 g^{-1} fresh weight.

Again, 10 grams of pulp tissues was homogenized in 50 mL of distilled water for 2 min using a kitchen blender and filtered through Whatman filter paper No. 2. The supernatant was collected in order to measure total soluble solids using a digital refractometer (Model NR151) and expressed as percentage, and titratable acidity expressed as citric acid (%) was determined by titration with 0.1 mol L^{-1} NaOH to pH 8.1 according to the method by Ranganna (1986).

Determination of formaldehyde in selected fruits and vegetables

Formaldehyde is a colorless, highly flammable gas that is sold commercially as 30–50% (by weight) aqueous solutions. It enters the environment from natural sources (including forest fires) and from direct human sources, such as automotive and other fuel combustion and industrial on-site uses.

The present experiment was carried out at Laboratory of Postharvest Technology Division, BARI, Gazipur during the year 2016-2017. Some common vegetables (cabbage, brinjal and tomato) and spices like onion and ginger were collected from local farmer. All samples were analyzed for determining naturally produced formaldehyde. To observe the effect of boiling on formaldehyde concentration all the samples were boiled for 5 and 10 minutes in boiling distilled water and then the samples were collected and determined formaldehyde concentration in the boiling sample. Tomato was analyzed both in green and ripe stage. Standard formaldehyde solution was used to observe actual behavior of formaldehyde during boiling for 0, 5,10,15 and 20 minutes. 37.123 ppm formaldehyde solution (2.5L) was made from 37% formaldehyde. 500mL solution was taken in 1000mL beaker and was placed on hot plate heater. After boiling, the solution was transferred in to volumetric flask and kept in ambient temperature. The solution was made to volume 500mL again with distilled water. Formaldehyde concentration in the solution was determined. The analytical procedure was followed according the method describe in AOAC (Method 931.08).

Extension of shelf life of ridge and sponge gourd by maintaining postharvest treatments and temperature

Fresh horticultural matured ridge and sponge gourd (local variety) was directly harvested from the farmers' field of Narsingdi at physiological age of 6-7d from fruit setting (according to farmers' perception). Then the gourd was transported to the Laboratory of Postharvest Technology Division, BARI, Joydebpur, Gazipur using plastic crates. Then the ridge and sponge gourd was pre-cooled at overnight. Then the gourd was sorted, graded, treated and stored.

Design of experiment: The experiment was laid out in completely randomized design (CRD) with two factors (Table 1). After treated, the gourd was packed with 1.50% perforation for ridge gourd and 1.00% perforation for sponge gourd. The thickness of the poly bag was 0.25mm thickness.

Physiological loss in weight (%): It was recorded by periodical weighing electronic balance (Model: AND, FX-2000, Japan) of ridge and sponge gourd and expressed as percentage of original weight according to the following formula. Damaged gourd was included with it (Amayogi and Alloli, 2007).

PLW (%) was determined by the formula of PLW= $\frac{W_0 - W}{W_0} \times 100$

Where PLW= Physiological loss in weight, W_0 = Initial weight and W = Final weight.

Decay Loss (%): The decay loss was determined according to the method of Amayogi and Alloli (2007). The decayed beans were weighed after 2 days interval and the percentage was calculated on the basis of total weight of the beans stored in different packages by using the following formula;

DL (%) = $\frac{W_0}{W} \times 100$

Where,
DL=Percent decay loss
W_0=Weight of decayed beans and
W= Weight of stored bean

Firmness (g): Firmness, as the force required to puncture the gourd, was measured using an Instron-Universal testing machine (Model 4201, USA) and expressed as kg-f/cm^2.

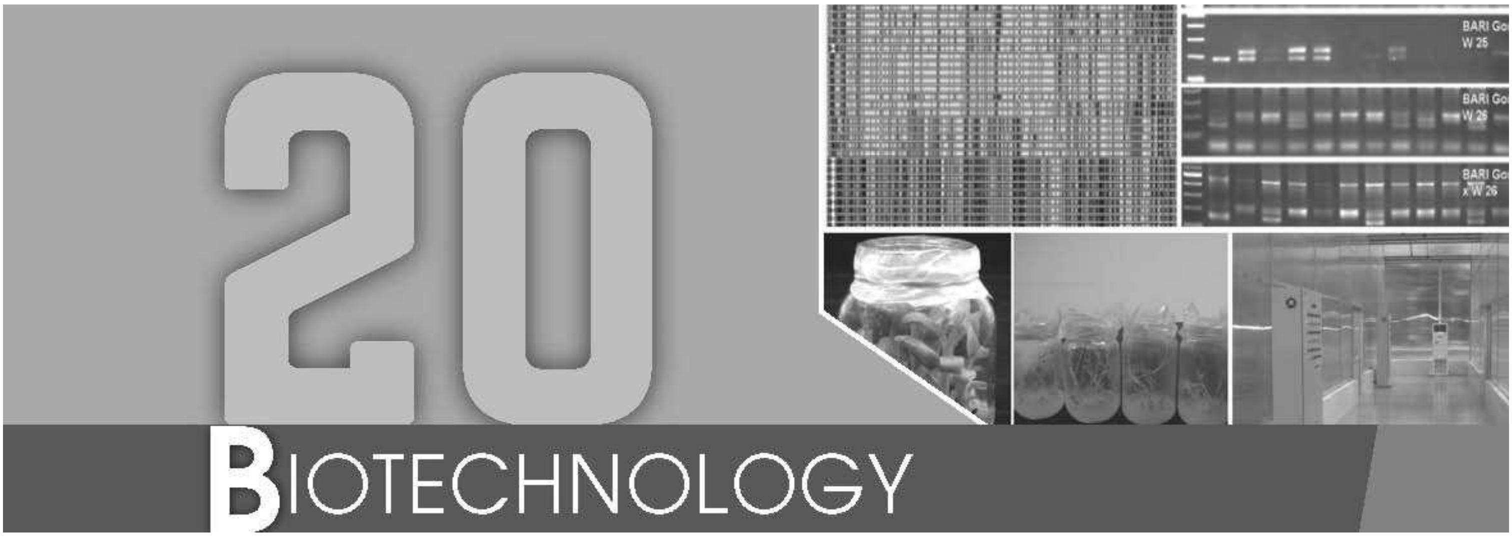
Measurement of ascorbic acid: For ascorbic acid measurement, 10g sample was homogenized in 50 mL of 3% cold metaphosphoric acid (HPO_3) using a blender for 2 min and filtered through Whatman filter paper No. 2. The clear supernatant was collected for assaying ascorbic acid by 2, 6-dichlorophenolindophenol titration following the method of Ranganna (1994). Ten milliliters of aliquot were titrated with 0.1% 2, 6-dichlorophenolindophenol solution until the filtrate changed to pink color persisted for at least 15 seconds and the titration volume of 2, 6-dichlorophenolindophenol was recorded. Prior to titration 2, 6-dichlorophenolindophenol solution was calibrated by ascorbic acid standard solution. Ascorbic acid content was calculated according to the titration volume of 2, 6-dichlorophenolindophenol and results were expressed as mg 100g^{-1} fresh weight.

Measurement of β-carotene: The estimation of β-carotene was done by the extraction of 3g product sample with acetone (Fisher Scientific Ltd., Uk) and petroleum ether. It was further purified with acetone, metabolic KOH and distilled water. The resulting solution was filtered with anhydrous sodium sulphate and read on a spectrophotometer (T-80, PG Instrument Ltd., UK) at 451nm against petroleum ether as a blank. A standard graph was plotted using synthetic crystalline B-carotene (Fluka, Germany) dissolved in petroleum ether and its optical density measured at 451 nm (Alasalvar *et al.*, 2005).

Marketable life (day): It was recorded on daily basis until the gourd spoilage and PLW level reaches below 10%, which is considered as maximum marketable life limit.

Table 1. Combined treatment of ridge and sponge gourd.

Combined Treatments	Details
A_0B_0	Without wash and stored at ambient condition
A_0B_1	Without wash and stored at 10±1^{0}C
A_0B_2	Without wash and stored at 13±1^{0}C
A_1B_0	Wash with clean water and stored at ambient condition
A_1B_1	Wash with clean water and stored at 10±1^{0}C
A_1B_2	Wash with clean water and stored at 13±1^{0}C
A_2B_0	Wash with NaOCl (150ppm) and stored at ambient condition
A_2B_1	Wash with NaOCl (150ppm) and stored at 10±1^{0}C
A_2B_2	Wash with NaOCl (150ppm) and stored at 13±1^{0}C



Protocol development and micropropagation

Study of comparative regeneration efficiency of different potato varieties

The experiment was carried out with a view to comparing regeneration efficiency of different potato varieties and selection of suitable potato varieties for genetic transformation. Internode explants of three BARI released high yielding potato varieties (BARI Alu-40, BARI Alu-41, and BARI Alu-25) and one exotic (Maris Piper) varieties were used. Five different concentrations (T_0, T_1, T_2, T_3, & T_4) of Zeatin Riboside in combination with GA_3 and IAA were used for regeneration of explants. Among the four varieties, the maximum responding variety was BARI Alu-41 and the best treatment combination was T_2 regarding percent shoot response, shoot height and leaf number.

In vitro regeneration of chickpea (*Cicer arietinum* L.)

The present study was undertaken to develop an efficient regeneration protocol of chickpea which will be used for future genetic transformation work. Embryonal axis of BARI chola 7 was used for *in vitro* regeneration. Six different treatments ($T_{1,}$ $T_{2,}$ $T_{3,}$ $T_{4,}$ T_5 & T_6) were used which consist of TDZ alone and in combination with 2ip and Kinetin. The maximum number of shoot (4.45) was obtained from T_2 treatment. The highest shoot length (5.72 cm) was obtained from T_4 treatment. When *in vitro* grown shoots were induced for rooting in four root induction medium, the maximum root (3.50) was obtained from T_2 treatment. The highest root length (3.62 cm) was also recorded from T_2 treatment. Well rooted plantlets were transferred to potting media containing sand, soil and compost at the ratio of 1:1:1 for establishment.

Development of an efficient regeneration system of banana

The present study was undertaken with a view to establishing a reliable regeneration protocol of banana (*Musa* spp.). Bottom portion and whole male flower buds were used as explant for callus induction. Explants were cultured on MS medium supplemented with different concentrations of 2, 4-D singly and in combination with different concentrations of IAA and NAA. In Bottom portion of male flower buds, among the four different treatments, the highest percentage of explant produced callus in T_2 treatment (56%) compared to other treatments. In whole male flower buds, the highest percentage of explant produced callus in T_1 and T_2 treatment (100%) compared to other treatment.

In-vitro Cormel Production of Gladiolus (*Gladiolus* sp.)

The experiment was conducted with a view to developing an efficient cormel production protocol of gladiolus. For *in vitro* cormel production of BARI gladiolus-4, corm sections with buds and nodal segments of inflorescence at heading stage were used as ex-plant which were cultured in MS medium with BAP (1.0, 2.0, 3.0, 4.0 and 5.0) mg L^{-1} and NAA at (0.5 and 1.0) mgL^{-1}. Shoot proliferation was the maximum in MS medium supplemented with BAP 2.0 mg L^{-1} and NAA 1.0 mg L^{-1}. On the other hand, shoot initiation started in the nodal culture within two weeks (13.8 days) of inoculation. The highest number of shoots per ex-plant (3.6) was obtained in MS medium supplemented with 4.0 mg L^{-1} BAP and 1.0 mg L^{-1} NAA. The longest shoot (8.5 cm) and leaves per shoot (3.6) was also found in the same treatment. The earliest rooting (11.6 days) and longest roots (5.3 cm) was observed in T_2

treatment i.e. MS media supplemented with IBA 2.0 mgL^{-1} and 5 % sucrose. After successfully regeneration of shoots, the plantlets were transferred into the cormel production media which consists of 3%, 5% and 7% sugar, 1.0 mgL^{-1} BAP and KIN supplemented with IBA. Among the treatments, C_2 (MS+ IBA 2.0 mgL^{-1} + sucrose 5%) performed better than all other treatments in case of cormel production. The treatment C_4 (MS+ IBA 1.0 mgL^{-1} + BAP 1.0 mgL^{-1}) did not produce any cormel during the study period.

In vitro* bulblet production of Hippeastrum *(Hippeastrum hybridum)

The study was undertaken with a view to developing a suitable and reproducible protocol for in-vitro propagation of Hippeastrum *(Hippeastrum hybridum)*.Twin scales from healthy and disease free bulb were used as ex-plant and cultured on MS media supplemented with different concentration of BAP (0.25, 0.5, 1.0 and 2.0) mgL^{-1} and NAA (0.3125, 0.625 and 1.25) mgL^{-1} along with a control. The response of the ex-plant varies with different concentration of plant growth regulators. MS media supplemented with BAP performed better than NAA in all other parameters. However, the highest percentage (98.33%) of shoot formation, number of shoots (2.24), shoot height (8.73 cm), fresh weight of shoots (544.7 mg) and earliest shoot proliferation (47.33 days) per ex-plant were found in T_2 treatment i.e. MS media supplemented with 0.5 mgL^{-1} BAP.

***In vitro* regeneration of bitter gourd (*Momordica charantia*)**

The experiment was carried out with a view to developing *in vitro* regeneration protocol of bitter gourd aiming to future genetic transformation. Leaf segments of BARI Korala-1 and 'Tia' were cultured on MS medium supplemented with different concentrations of 2, 4-D. Considering the percent of callus formation and weight of callus treatments, 1.5 and 2.0 ml/l 2, 4-D were found better in both varieties.

***In vitro* regeneration of grass pea (*Lathyrus sativus* L.)**

The present experiment was undertaken to develop a standard and efficient regeneration protocol of grass pea (*Lathyrus sativus* L.). Seedling-derived cotyledonary nodes of BARI Khesari-3 were cultured *in vitro* on MS medium supplemented with varying concentrations of 6-benzylaminopurine (BAP). Direct shoot regeneration was observed from the explants. The highest percentage (58.33%) of response was observed in T_3 and the highest no. of shoots/explant (13) was found in T_4. The experiment will be continued in the next year.

Large scale production of BARI released banana through tissue culture

The experiment was undertaken as per the recommendation of the Secretary, MOA to produce more banana plantlets through tissue culture and distribute the plantlet throughout the country. Sword suckers of an advanced line of plantain were collected from the farm field of pomology division, HRC. Due to its better performance than the previously released BARI Kola -2 variety the pomology division has a demand to increase its planting materials. That's why this line was taken under consideration this year for multiplication. Shoot tips were separated from those suckers and cultured on existing protocol based medium for in vitro production. Due to unavailable supply of sword suckers of the advanced line only 30 shoot tips were cultured on the shooting medium (5mg/l BAP).Banana is a high value fruit crop. It has a great demand to the consumer level. For its well distribution micro propagation may play a pivotal role.

Rescue of amritsagar banana from extinction through biotechnological approaches

The experiment was conducted with a view to collection, *in vitro* propagation of Amritsagar banana variety and to prevent the extinction of the variety by reintroducing its cultivation at farmers' level. Amritsagar banana was collected from different location of the country such as Mymensingh, Gazipur, Norshingdi, Sylhet etc. and mother orchard has been established at research field of Biotechnology division, BARI, Joydebpur, Gazipur. Amritsagar banana collected from Gafargaon and Kapashia were compared with each other by following the standard descriptor for banana (*Musa spp*.). This comparison demonstrates that Amritsagar banana (Kapashia) is more superior to Amritsagar banana (Gafargaon) in respect of fruit length, diameter, weight, total fruit number and bunch weight. Shoot tips of Amritsagar banana (Gafargaon & Kapashia) were cultured on MS medium supplemented with different concentrations of BAP. Five treatments were tested for this study. Among the treatments, maximum no. of shoots was observed in T_3 treatment in both lines. Well-developed shoots were transferred into ½ MS medium supplemented with different conc. of IBA for root induction. Five different treatments were (T_0, T_1, T_2, T_3 and T_4) tested and maximum numbers of longest roots were observed in both lines in treatment T_3. The plantlets were transferred into the poly bag containing soil and cowdung mixture.

Molecular Genetics and Genetic Engineering

PCR-based detection and characterisation of tomato leaf curl and other related geminiviruses in Bangladesh

The experiment was conducted with a view to characterising Geminivirus strains in different crops beginning with tomato. In the present experiment, genomic DNA was extracted from the 58 leaf samples of 12 cucurbit crops showing virus like symptoms collected from 5 districts of the country. Isothermal amplification method followed by restriction digestion was used for initial detection of the virus. Results of the pairwise sequence comparison of the virus coat-protein gene showed the presence of two tomato infecting Geminiviruses where only a single species (*Tomato Leaf Curl New Delhi Virus*) was identified from 29 of the 30 samples. A phylogenetic tree was constructed and analyses of the sequences confirmed the above findings and show the ability of tomato leaf curl viruses to infect a wide host range.

Transformation of tomato for broad spectrum resistance against leaf curl viruses

Several experiments were conducted with a view to genetically transform tomato plants for broad-spectrum resistance against leaf curl viruses. Based on the genome sequence of various TYLCV strains, DNA fragments from three diverse TYLCV species were amplified and cloned. Previously two plasmid vectors were constructed for transformation work. Shoot regeneration has been observed from tomato explants following co-cultivation with *Agrobacterium* harbouring one of the binary vectors. Infectious clones of the most virulent leaf curl virus species were constructed and *Nicotiana benthamiana* indicator plants along with tomato plants were Agro-inoculated resulting in the expression of leaf curl virus disease symptoms.

Marker-assisted transfer of salt tolerance *Nax* genes in Bangladeshi wheat varieties

The experiment was conducted with a view to develop salt tolerant wheat varieties using marker assisted selection. Two salt tolerant (*Nax1; Nax2*) Australian wheat lines having Westonia background were crossed with two popular Bangladeshi wheat varieties BARI Gom-25 and BARI Gom-26. Last year 192 plants carrying the salt tolerance genes were selected using molecular markers from BC_3S_1 generation. This year a total of 82 plants were selected from BC_3 S_2 generation. Seeds (BC_3S_3) were harvested and preserved for further research.

Effect of heat stress on protein expression in potential Bangladeshi tomato varieties

The experiment was conducted with a view to determine the effect of heat stress on protein expression in tomato leaves and other plant parts and to find out the cultivar differences at protein expression level under heat stress condition. The experiment was conducted based on expression of heat shock protein in BARI released promising summer variety and high yielding tomato varieties. Four BARI released promising tomato varieties and their four parental lines were selected for this experiment. Attempts were made to identify heat shock protein and to differentiate the heat tolerant tomato varieties in context of overly expressed of heat shock protein. Total plant proteins including large and small heat shock proteins were extracted and SDS-PAGE was done to get an idea about the extracted proteins. Results obtained from this experiment can be used for the further experiments in this field.

Molecular characterization of natural edible mushrooms in Bangladesh

The experiment was conducted with a view to establishing the identities of natural collections of mushrooms that will contribute to addition of indigenous edible mushrooms in Bangladesh. Ten natural edible mushrooms were collected from Khagrachari and Moulvibazar districts of Bangladesh during April-June, 2017. Only 4 mushroom samples (sample 1, 6, 7 and 9) could be identified up to the genus level by morphological observation and all of those belong to the genus *Pleurotus*. In case of tissue culture, among 10 samples only one sample (i.e S-6) could be grown on PDA medium and others did not survive. Mycelium of the culturable sample was white in colour, size of the colony on the 8th day of culture was 3.1cm and the density of colony was deep. In case of molecular characterization, DNA extraction was completed for all the collected samples.

FtFBP research activities

Breeder seed production of Bt brinjal varieties

Breeder seed production programme of released four Bt brinjal varieties i.e. BARI Bt Begun 1, BARI Bt Begun 2, BARI Bt Begun 3 and BARI Bt Begun 4 was conducted at 11 locations of BARI (Burirhat, Dinajpur, Rangpur, Bogra, Pabna, Ishurdi, Jamalpur, Gazipur, Barisal, Jessore, Pahartali in 5.6 ha (42 bhigas) of land with the view to produce good quality Bt brinjal seed. The amount of seed harvested as 84, 337, 202 and 295 kg from BARI Bt Begun 1, BARI Bt Begun 2, BARI Bt Begun 3 and BARI Bt Begun 4, respectively. The total amount of seed was 1068 kg against the target of 800 kg.

Generation advancement of Bt brinjal lines

A field trial on generation advancement of two Bt brinjal lines (Bt Chega and Bt Islampuri) were conducted at the confined field of Biotechnology Research Field, BARI Gazipur. Considering the distinctiveness, uniformity and stability of the lines, Bt Chega may be proposed to release as a new Bt brinjal variety. Fruit shape, size and colour of Bt Islampuri was not up to the mark. Moreover, there were very few numbers of fruits (one or two) and even no fruits were found in plant. Hence, it should be discarded for further research to propose as a new variety.

Maintenance of Bt brinjal varieties

A field trial was conducted for maintenance of released Bt brinjal varieties and Bt Brinjal lines at the confined field of Biotechnology Research field, BARI Gazipur. Standard cultivation procedures were followed for the seed production. The unit plot size was 48 m^2 which was replicated in three. The plots were covered with mosquito net before the flowering stage and off -types plants were removed at the fruiting stage. Bt Islampuri was not considered because of unavailability of ideal fruit. The amount of seed harvested from Bt Dohazari, Bt Khatkhatia, Bt Singnath, Bt Chega, BARI Bt Begun 1, BARI Bt Begun 3 and BARI Bt Begun 4 as 175 g, 80g, 130g, 420g, 140g, 220g and 155g, respectively.

Measuring gene flow in the cultivation of Bt brinjal

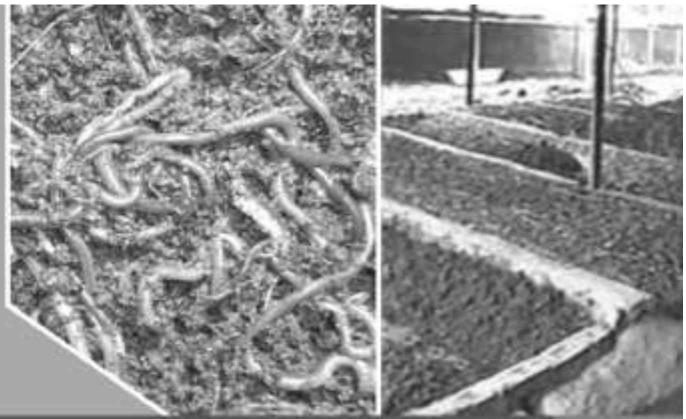
Bt brinjal was introduced in Bangladesh in 2013 as first genetically engineered crop. The inevitable coexistence between transgenic and conventional brinjal requires the assessment of transgene outflow.

The study was carried out at Biotechnology Research field, BARI, Gazipur during the winter season of 2016-17. The experimental design consisted of 12m x 12 m Bt brinjal plot surrounded by non-Bt plants. Different distances i.e. 1m, 2m, 4m, 6m, 9m and 18m between the Bt and the non-Bt field at four directions (North, South, East and West) were considered. Standard cultural management practices were applied in both Bt and non-Btbrinjal plants. After harvesting of non-Bt fruits, the presence of transgene (*Cry1Ac*) was assessed by lateral flow strip method using DGX020-DesiGenXpresstrips detection kits (Mahyco, India). On an average of four directions the plants showed out crossed at the distance of 1m, 2m, 4 m, 6m, 9m and 18m were 14%, 8.5%, 3.5%, 2.25, 2.5% and 1.75%, respectively. In total, 130 out of 2400 plants (5.42%) showed out crossed. The range of outcross was 0 to 21%.

Production of breeder's propagule of transgenic late blight resistant potato clone through tissue culture

The experiment was carried out with a view to producing plantlets/minitubers of selected LBR potato clone. Transgenic D 951 (137), SP 951 and non-transgenic Katahdin were used in this study. Sprouts of these varieties were used as explant. Sprouts were cultured on PROP medium and multiplied *in vitro.* Initially, 30 tubers of D 951 (137) were used. Plantlets from individual tuber of D 951 (137) were multiplied and tested for virus free material. For that ELISA test were performed and 10 materials were found virus free. Only those materials were maintained and multiplied. From *in vitro* culture, a total of 2109 plantlets were produced of which 234 plantlets were non-transgenic Katahdin, 185 plantlets were SP 951 and 1690 plantlets were D 951 (137). Some plantlets were transferred to green house for mini tuber production. About 78- 86% plantlets were survived in green house.

21 SOIL MANAGEMENT



Physical Aspects of Soil Management

Determination of crop coefficient values of broccoli and estimation of leaching loss of nutrients by drainage lysimeter

A study on broccoli (cv. Green King) was conducted in the drainage Lysimeter located in the Central Research Farm, BARI, Gazipur during rabi 2016-17. The objectives of the study were to find out the location specific crop coefficient (Kc) values of broccoli and to estimate leaching loss of nutrients. Four regimes of irrigation water was applied on the basis of depletion over field capacity (FC) at pre determined intervals such as T_1: Irrigation up to FC at 5 days interval, T_2: Irrigation up to FC at 10 days interval, T_3: Irrigation up to FC at15days interval and T_4: Irrigation up to FC at 20 days interval. As such, 14, 7, 5 and 3 irrigations were needed for T_1, T_2, T_3 and T_4, respectively. The experiment was conducted in completely randomized design with 3 replications. The highest curd yield (14.57 t ha^{-1}) was obtained from T_2, which was statistically identical to T_1 but significantly higher over T_3 and T_4. Therefore, Kc values were calculated from the best performed treatment, T_2. The estimated Kc values of broccoli found to be 0.50, 0.68, 1.06 and 0.73 for initial, crop development, mid season and late season stages, respectively. The estimated Kc values derived from this experiment could be used under Bangladesh context and alike agro-climatic conditions for the determination of water requirement of broccoli. Significant amount of plant nutrients (P, K, Ca, Mg, S, Zn and B) was lost through leaching. The loss of Ca, Mg and S found to be a great concern. This should be taken into account for ensuring crop nutrition and minimizing ground water pollution.

Effects of tillage methods and residue management on soil properties and yield of Potato- Maize-T. aman rice cropping pattern

Field experiments on Potato- Maize-T.aman rice cropping pattern were conducted in Grey Terrace Soil of Gazipur under AEZ-28 and Dark Grey Floodplain Soil of Jamalpur under AEZ-9. The experiment started in 2013-14 where third cycle was completed in October 2016 and is reported this year (2016-17). The objectives of the study were to observe the effect of tillage practices and residue management on soil properties and to increase the productivity of the said cropping sequence. Three tillage methods such as minimum tillage (4-6 cm depth) with power tiller operated seeder (PTOS), conventional tillage (10-12 cm depth) with power tiller and deep tillage (20-25 cm depth) by spading were employed. Besides, three types of residue management options viz. farmers practice (without residue), 50% crop residue incorporation and 100% crop residue incorporation for potato and 15 cm and 30 cm stubbles of maize and rice were incorporated to soil for the subsequent crops. The study was conducted in a factorial randomized complete block design with three replications. Deep tillage gave significantly higher yield over minimum tillage for all three crops of the pattern except T. aman rice at Jamalpur. But for the third cycle (2015-16), the effect of deep tillage reduced greatly producing significant yield only for potato at Gazipur. The benefits of crop residue retention appeared to be statistically significant for 9th crop (T. aman rice) onward after retention of consecutive 7 crops residues. Minimum tillage irrespective of residue retention showed the yield loss over conventional practice ($T_2 \times M_1$) although such reduction was lower in residue treated plots. The potato equivalent yield (PEY) was found almost similar to third cycle (2015-16) and second cycle where the highest PEY (42.97 and 41.13 t ha^{-1}, Gazipur and Jamalpur, respectively) was obtained from $T_3 \times M_3$, which was about to $T_3 \times M_2$. Yield benefit for $T_3 \times M_3$ over traditional practice (T_2M_1) was 30 and 16% for Gazipur and Jamalpur, respectively while it was 27 and 13% for $T_3 \times M_2$ with the same order for the location. Although the PEY was higher for the second cycle than the third one but the yield benefit for the third cycle was greater, which indicated the value of cumulative residue retention practice over the years. The 4th cycle of the pattern is continuing (2016-17) with 11th crop maize is in harvesting stage till the preparation of the present report.

Effect of Tillage Methods and Compost Based IPNS Package on the Productivity of Radish-Pea-Okra-T. Aman Rice Cropping Pattern and Sustainability of Soil Health

Field trials were conducted at Central Research Farm at Gazipur (AEZ-28) and at RARS, Jessore (AEZ-11) during rabi 2014-2015 and 2015-16. The objectives were to find out the suitable dose of compost and chemical fertilizers for maximizing the yield of Radish-Pea-Okra-T. aman rice pattern and to know the effect of tillage methods and compost based IPNS package on the improvement of soil health. There were three tillage methods, such as T_1= Minimum tillage, T_2= Conventional tillage and T_3= Deep tillage: and four nutrient management practices viz. NM_1= 100% STB as per FRG, 2012 all from chemical fertilizer, NM_2= 125% STB all from chemical fertilizer, NM_3: NM_1 (75% from chemical fertilizer + 25% from compost) and NM_4: Native fertility. The experiment was set up in two factors Randomized Complete Block Design with 12 treatments and 3 replications. The highest root yield (23.5 and 20.0 t ha^{-1}) of radish and pod of garden pea (1.86 and 4.54 t ha^{-1}) was recorded from deep tillage, which was significantly higher over conventional tillage and minimum tillage (4-6 cm depth). The next 2 crops of the pattern okra and T. aman rice did not responded significantly to tillage depth. For the second cycle the effect of tillage found to be statistically non-significant. All 4 crops of the pattern responded significantly to nutrient management packages where the highest yield was recorded either from 125% STB dose or NM_3 (IPNS based dose) for the first year. The performance of NM_3 was much pronounced in the second year. It was found that 25% increased fertilizer dose over present recommendations (FRG, 2012) is required for maximizing the yield. But IPNS approach formulated preferably with conventional compost having 75: 25 inorganic: organic ratio may save the requirement of 25% chemical fertilizer without yield reduction. Deep tillage produced higher yield, which was almost similar to conventional tillage when it combined with compost formulated IPNS package. Radish equivalent yield (REY) varied from 23.31 to 61.02 t ha^{-1} at Joydebpur and 35.80 to 68.73 t ha^{-1} at Jessore where the highest REY was observed from $T_3 \times M_2$ which was closely followed by $T_3 \times M_3$ and the lowest in $T_1 \times M_4$. The REY for the second cycle was found numerically highest for $T_3 \times M_3$ followed by $T_3 \times M_2$. The experiment is in progress with third cycle where eleventh crop, okra is about to the end of harvesting stage and the next crop t. aman rice is followed till the preparation of the present report.

Effect of Tillage and Nitrogen on the Mustard- Boro- T. Aman Rice Cropping System Under Conservation Agriculture Practice

An experiment was conducted at BARI Central Research Farm, Joydebpur and RARS, Ishurdi during rabi season in 2016-17 to evaluate the effects of tillage and nitrogen fertilizer on soil physico-chemical properties and crop yields along with to assess the system productivity in the Mustard- Boro- T. aman cropping system. Two tillage practices such as, T_1: strip tillage (ST) and T_2: conventional tillage (CT) was assigned in main plot and three levels of N fertilizer such as N_1: 75% of recommended N-fertilizer dose (RND), N_2: 100% of recommended N-fertilizer dose (RND) and N_3: 125% of recommended N-fertilizer dose (RND) was allotted in sub-plot in a split-plot design with three replications. The tested mustard crop (cv. BARI Sharisha 14) was sown on 15th & 20th November of 2016 and harvested on 13th & 16th February of 2017 at Joydebpur and Ishurdi, respectively. The highest weed infestation was recorded in ST with 125% N-fertilizer applied plots (143 g m^{-2} at Joydebpur and 261 g m^{-2} at Ishurdi) and CT with 75% N-fertilizer applied plots produced minimum weed (70 g m^{-2} at Joydebpur and 123 g m^{-2} at Ishurdi). Tillage practices had significant effects on number of siliqua plant^{-1}, but no variations were found in other parameters at Joydebpur whereas at Ishurdi, significantly higher plant population m^{-2} was found in CT practice (83.6 nos. m^{-2}) and fewer plants m^{-2} were recorded in CT practice (42.2 nos. m^{-2}) but higher number of siliqua plant^{-1} (69.7) was recorded in ST practice than CT practice (57.6). Tillage practices had significant differences on grain yield of mustard at RARS, Ishurdi but not at Joydebpur and higher grain (1.38 t ha^{-1}) was found in CT and the lower grain (1.11 t ha^{-1}) was recorded in ST practice at Ishurdi. On the other hand, different N fertilizer levels showed significant variations in on number of branches plant^{-1} of mustard at Joydebpur and the highest number of branches plant^{-1} was found in N_3 level and the lowest number of branches plant^{-1} was obtained in N_1. Different N-levels showed significant differences in seed yield of mustard at Joydebpur and the highest seed (1.43 t ha^{-1}) was obtained in N_3 treatment, followed by N_2 treatment (1.25 t ha^{-1}) and lowest seed (0.99 t ha^{-1}) was obtained in N_1 treatment. In case of RARS, Ishurdi, different N fertilizer levels showed significant variations in plant height of mustard and the significantly tallest plants were observed in N_3 level (88.4 cm) and the shortest plants were obtained in N_1 level (81.5 cm). N-levels had significant differences on straw yield of mustard at Joydebpur and RARS, Ishurdi regardless of tillage practices. The highest straw yield of mustard (1.40 t ha^{-1} at Joydebpur and 1.28 t ha^{-1} at Ishurdi) was observed in 125% of RND and the lowest straw yield of mustard (1.29 t ha^{-1} at Joydebpur and 1.16 t ha^{-1} at Ishurdi) was observed in 75% of RND. Root weight of mustard by oven dry was significantly influenced by different N levels and the highest root mass (2.10 & 2.24 g plant^{-1}) was observed in N_3 treatment and the lowest root mass (1.39 & 1.53 g plant^{-1}) was observed in N_1 treatment at Joydebpur and Ishurdi, respectively.

Effect of Minimum Tillage and Crop Residue Retention on Soil Physico-Chemical Properties and Crop Yields Under a Rice-Based Cropping System

An experiment was conducted at BARI Central Farm, Joydebpur and RARS, Jessore during rabi season in 2016-17 to observe the effects of tillage and crop residue on soil physico-chemical properties and crop yields, to find out the optimum combination in tillage systems and crop residue retention levels for better soil health along with to assess the system productivity in rice-based cropping system. In the first year of the experiment, two practices such as, T_1: conventional tillage (CT) and T_2: strip tillage (ST) were assigned in main plot and two levels of crop residue retention will be maintained from second crop, such as R^+/S_1: thirty (30) cm previous crop residue retention/incorporation of wheat and rice and full straw retention of mungbean, and R^-/S_2: removal of crop residue (farmers' practice) in sub-plot in a split-plot design with four replications. The tested wheat crop (cv. BARI Gom 30 at Joydebpur & BARI Gom 26 at RARS, Jessore) was sown on 28 & 29 November of 2016 and harvested on 15 & 19 March of 2017, respectively. Tillage had significant influence on the number of spikes m^{-2} at Jessore and significantly higher number of spikes m^{-2} was obtained in strip tilled plots than conventionally tilled plots while did not show any remarkable variations in other yield and yield contributing characters both locations. In addition, numerically longer spike and number of grains spike^{-1} was found in ST plots than CT plots. Consequently, not statistically but numerically higher grain yield (4.31 & 4.65 t ha^{-1}) was found in ST and lower grain yield (4.01 & 4.45 t ha^{-1}) was recorded in CT practice at Joydebpur and Jessore, respectively.

Effect of Tillage Methods and Integrated Nutrient Management on Soil Properties and Productivity of Mustard-Mungbean- T. Aus –T. Aman Rice Cropping Pattern

Field experiment on Mustard-Mungbean-T.aus-T.aman rice cropping pattern was conducted in Grey Terrace Soil of Joydebpur under AEZ-28 during rabi 2015-16 to observe the effect of tillage practices and integrated nutrient management on soil properties and to increase the productivity of the said cropping sequence. There were 3 types of tillage such as minimum tillage (T_1), conventional tillage (T_2) and deep tillage (T_3). In addition, 4 fertilizer packages such as 100 % STB dose (NM_1), 125 % STB dose (NM_2) and 100 % STB formulated with cow dung based IPNS (NM_3) and without fertilizer (NM_4) were studied in a two factor RCB design with 12 treatments and 3 replications. Both tillage and nutrient management packages produced significantly higher seed yield of mustard. Deep tillage performed significantly higher over minimum tillage and conventional tillage in case of mustard and mungbean but did not show any response in case of T. aus and T. aman rice. All crops of the said cropping pattern performed significantly to nutrient management packages where highest performance was observed either from 125 % of STB dose or from IPNS based dose. It was observed that extra 25 % fertilizer dose over present recommendation (FRG, 2012) appeared to be remunerative for maximizing the yield that demand could be minimized with IPNS dose without yield retrenchment. Deep tillage carried out the highest performance when it linked with IPNS and 125 % of STB dose. Rice equivalent yield of the said cropping pattern varied from 8.55 to 15.21 t ha^{-1} where the highest REY was observed from $T_3 \times M_3$ which was followed by $T_3 \times M_1$, $T_2 \times M_3$ and $T_3 \times M_2$ and the lowest REY was observed from $T_2 \times M_4$ combination. The experiment is in progress with seventh crop, T. aus rice is in maturity stage during report presentation.

Note: NM= Nutrient management and T=Tillage

Measurement of Soil Physical and Chemical Properties for Regional Wheat Research Farm of Bari, Gazipur

An inventory work for the measurement of soil physical and chemical properties of Regional Wheat Research farm of BARI was wielded during 2016-17. A total of 12 composite soil samples maintaining 3 depths (0-20, 20-40 and 40-60 cm) were collected from Block 26 under Regional Wheat Research farm of BARI. Upper two layers of soil represent sandy loam texture while other two layers belong to sandy clay loam, which reverberate the rampant of sand deposition due to land development with imported soil. Bulk density varied from 1.47 to 1.66 g cc^{-1} where sub-block D gave lower bulk density than other sub- blocks. Field capacity (FC) varied from 25.27 to 30.33% where the highest result was observed from D sub-block and the lowest in sub-block A. The lower moisture retention due to exceeding and might have created drainage congestion in the substratum. Soil reaction (pH) of the studied soil appeared to be slightly acidic to neutral. Sub block D gave relatively higher pH than other sub blocks. Organic matter content was reasonably good in top soil but poor in sub soil. The content of total -N is very low in all sub blocks. Phosphorus content of the tested soil was medium to optimum whereas S content was low to medium in A, b, C sub blocks and medium to optimum in sub block D. The tested soil retained good amount of calcium and magnesium whereas low in potassium content. Micronutrient like zinc was medium to high with few exceptions. Boron content is low whereas other micronutrients were rich in amount.

Chemical Aspects of Soil Management

Nutrient Management for Sustaining Soil Fertility and Performance of Wheat- Mungbean-T.Aman Cropping Pattern at Ishurdi

A field experiment on Wheat-Mungbean-T.aman cropping pattern was carried out in High Ganges River Floodplain Soils (AEZ-11) at Regional Agricultural Research Station, Ishurdi, Pabna during the period of 2000-16. There were six treatments viz. 125% of recommended dose (RD =120-35-75-20-5 kg of N P K S Zn ha^{-1}), 100% of RD, 75% of RD, 50% of RD, farmer's practice and native fertility replicated three times. Highest total rice (system) yield of 15.67 t ha^{-1} $year^{-1}$ was obtained from T_1 treatment (125% RD) which was similar to the 100% RD treated plot. Lowest total rice (system) yield of 8.29 t ha^{-1} $year^{-1}$ was obtained from control i.e. native fertility treatment (T_6). Highest gross margin of 172557 Tk. ha^{-1} $yr.^{-1}$ was also obtained from T_1 treatment (125% RD). The highest benefit cost ratio of 2.24 was found in T_2 treatment (100% RD). The results revealed that soil fertility sustained in 125% of RD and 100% of RD treatments.

Nutrient Management for Sustaining Soil Fertility and Performance of Mustard-Mungbean-T.Aman Cropping Pattern At Ishurdi

A field trial was carried out at Regional Agricultural Research Station, Ishurdi, Pabna during the period of 2000-17 in High Ganges River Floodplain Soils (AEZ-11) of Ishurdi to find out sustainable fertilizer doses for Mustard-Mungbean-T.aman cropping pattern, to monitor soil health and productivity of the cropping pattern. There were three levels each of N (80, 120 and 160 kg ha^{-1}), P (18, 36 and 54 kg ha^{-1}) and K (35, 70 and 105 kg ha^{-1}) in the treatment combinations. The combined effect of 120-36-70-40-3-1 kg ha^{-1} of NPKSZnB (T_2) produced the highest grain yield (1.56 t ha^{-1}) of Mustard, grain yield (1.45 t ha^{-1}) of Mungbean and grain yield of T. aman (5.45 t ha^{-1}). Highest total rice (system) yield of 15.15 t ha^{-1} year^{-1} was obtained from T_2 treatment. Lowest total rice (system) yield of 10.96 t ha^{-1} year^{-1} was obtained from control i.e. native fertility treatment (T_8). Highest gross margin of 146630 Tk. ha^{-1} yr.$^{-1}$ and the highest benefit cost ratio of 1.94 was found in T_2 treatment. The average soil fertility status were mostly unchanged, somewhere it was changed positively. As K showed negative balance, more K is to be added to improve soil fertility status.

Effect of IPNS for Sustaining Soil Fertility and Yield of Crops on Maize-Mungbean-T. Aman Rice Cropping Pattern

The experiments were conducted at BARI, Gazipur and OFRD, Bogra during 2014-15 and 2015-16 with the objectives to maintain soil productivity through a balanced use of mineral fertilizers combined with organic sources of plant nutrients, improve the efficiency of plant nutrients, thus limiting losses to the environment, increase sustainable crop yield and to increase farmer's income. There were eight treatments viz. T_1: Native fertility, T_2: 75% STB, T_3: 100% STB, T_4: 75% STB + 3 t ha^{-1} PM, T_5: 3 t ha^{-1} PM + IPNS, T_6: 75% STB + 5 t ha^{-1} CD, T_7: 5 t ha^{-1} CD + IPNS and T_8: 125% STB. IPNS means releasing amount of nutrients of cowdung and poultry manure were subtracted from STB chemical fertilizers. The experiment was laid out in RCB design with three replications. Data revealed that the T_5 (3 t PM + IPNS) treatment produced the highest grain yield of maize both at Gazipur (8.46 t ha^{-1} in 2014-2015 and 8.73 t ha^{-1} in 2015-16) and at Bogra (8.11 t ha^{-1} in 2014-2015 and 9.67 t ha^{-1} in 2015-16). The highest grain yield of T. aman at Gazipur were 3.82 t ha^{-1} (in 2014-2015) & 4.60 t ha^{-1} (in 2015-16) and at Bogra were 3.81 t ha^{-1} (in 2014-2015) & 5.40 t ha^{-1} (in 2015-16) obtained from T_5 (3 t PM + IPNS) treatment. The highest benefit cost ratio was found in T_7 (5 t CD + IPNS) treatment at both of the locations. Most of the chemical properties of post harvest soil increased due to incorporation of organic manures through integrated plant nutrition system.

Effect of IPNS on the Yield and Nutrient Uptake of Crops on Cauliflower-Amaranth-T. Aman Cropping Pattern

A field experiment on Cauliflower-Amaranth-T. aman cropping pattern was conducted in the Grey Terrace Soil (AEZ-28) of Gazipur and Tista Meander Floodplain Soil (AEZ-3) at OFRD, Bogra during the year of 2014-15 and 2015-16 with the objectives to maintain or enhance soil productivity through a balanced use of mineral fertilizers combined with organic sources of plant nutrients, improve the efficiency of plant nutrients thus limiting losses to the environment and to increase sustainable crop yield. There were eight treatments viz. T_1: Native nutrient, T_2: 75% STB T_3: 100% STB, T_4: 75% STB + 3 t ha^{-1} PM, T_5: 3 t ha^{-1} PM + IPNS, T_6: 75% STB + 5 t ha^{-1} CD, T_7: 5 t ha^{-1} CD + IPNS and T_8: 125% STB. IPNS means releasing amount of nutrient of cowdung and poultry manure were subtracted from STB chemical fertilizers. The experiment was laid out in RCB design with three replications. Data revealed that the T_5 treatment produced the highest yield of cauliflower 48.10 & 52.70 t ha^{-1} at Gazipur and 43.0 & 51.33 t ha^{-1} at OFRD, Bogra during the year 2014-2015 and 2015-16, respectively. This trend of influence was consistent for almost all the yield contributing characters of cauliflower in both the location. The highest yield (63.33 t ha^{-1}) of amaranth was noted in T_5 (PM + IPNS) treatment. The highest grain yield of T. aman 4.27 & 4.76 t ha^{-1} at Gazipur and 5.10 & 5.46 t ha^{-1} at OFRD, Bogra were produced by T_5 (3 t PM + IPNS) treatment during the year 2014-2015 and 2015-16, respectively. The native nutrient treatment produced the lowest yield in case of all crops. The highest benefit cost was found in T_7 (5 t CD + IPNS) treatment at both of the locations. Most of the chemical properties of post harvest soil increased due to incorporation of organic manures through integrated plant nutrition system.

Effect of Organic Manures on Vegetable Crop Production and Carbon Accumulation in Soil

A field experiment on effect of organic manure on Broccoli was conducted in the Grey Terrace Soil (AEZ 28) of Gazipur during the year of 2016-17 with the objectives to enhance soil productivity through the use of integrated plant nutrition system (IPNS) of mineral fertilizers and organic sources of plant nutrients, improve the efficiency of plant nutrients thus limiting losses to the environment and to increase sustainable crop yield. There were six treatments viz. T_1: Native nutrient, T_2: 75% STB, T_3: 100% STB, T_4: 5 t ha^{-1} CD + IPNS, T_5: 3 t ha^{-1} PM + IPNS, T_6: 3 t ha^{-1} VC + IPNS. IPNS means releasing amount of nutrient of cowdung, poultry manure and vermicompost were subtracted from STB chemical fertilizers. The experiment was laid out in RCB design with four replications. Data revealed that the T_4 treatment produced the highest yield of broccoli 19.89 t ha^{-1}. This trend of influence was consistent for almost all the yield contributing characters of broccoli. The native nutrient treatment produced the lowest yield (10.41 t).

Development of Fertilizer Recommendation for Four Crop Based Cropping Pattern: Mustard-Boro-T.Aus-T.Aman

A field experiment on Mustard-Boro-T.Aus-T.Aman cropping pattern was conducted in Old Brahmaputra Floodplain Soil of Jamalpur (AEZ 9) and High Ganges River Floodplain Soil of Jessore (AEZ 11) during the years of 2014-15 and 2015-16 with the objective of finding out suitable fertilizer combination for sustainable yield of the pattern, monitoring soil health as affected by chemical fertilizers and to make a balanced sheet of each nutrient. There were eight different treatments viz. T_1: 100% NPKSZnB (STB), T_2: T_1 + 25% N, T_3: T_1 + 25% NP, T_4: T_1 + 25% NK, T_5:T_1 + 25% PK, T_6:T_1 + 25% NPK, T_7: 75% of T_1,T_8: Native fertility. The experiment was laid out in RCB design with three replications. Data revealed that the yield of mustard (BARI Sarisha 14) grain yield was statistically influenced by the fertilizer treatments. The highest mustard grain yield both at Jamalpur (1.86 t ha^{-1} in 2014-2015 and 1.78 t ha^{-1} in 2015-16) and Jessore (1.72 t ha^{-1} in 2014-2015 and 1.61 t ha^{-1} in 2015-16) were produced from the treatment T_6 where 25% extra NPK was added over the 100% STB fertilizer rate. This yield was statistically superior to all the other fertilizer treatments. Boro, T. Aus and T. Aman rice yield was influenced significantly. The treatment T_6, showed the highest yield for Boro, T. Aus and T. Aman rice which is statistically identical to all other treatment except control i.e. native fertility treatment (T_8). Highest total rice (system) yield of 16.79 t ha^{-1} year^{-1} was obtained from T_6 treatment where 25% NPK was added with 100% STB rates. Lowest total rice (system) yield of 10.67 t ha^{-1} year^{-1} was obtained from control i.e. native fertility treatment (T_8). Among the eight treatments, the highest gross return (4,03,079 Tk. ha^{-1}) as well as gross margin (2,77,902 Tk. ha^{-1}) and highest BCR (0.45) was obtained from T_6 treatment where 25% NPK was added with 100% STB rates.

Development of Fertilizer Recommendation for Four Crop Based Cropping Pattern: Potato-Boro- T.Aus-T.Aman

A field experiment on Potato-Boro-T. Aus-T.Aman cropping pattern was conducted in the High Ganges Floodplain Soil of Jessore (AEZ 11) during the year of 2014-15 and 2015-16 with the objectives of finding out suitable fertilizer combination for sustainable yield of the pattern, monitoring soil health as affected by chemical fertilizers and to make a balanced sheet of each nutrient. There were eight different treatments viz. T_1: 100% NPKSZnB (STB), T_2: T_1 + 25% N, T_3: T_1 + 25% NP, T_4: T_1 + 25% NK, T_5: T_1 + 25% PK, T_6: T_1 + 25% NPK, T_7: 75% of T_1, T_8: Native fertility. The experiment was laid out in RCB design with three replications. Data revealed that the tuber yield of potato, grain yield of boro, T.Aus and T.Aman were significantly influenced by the fertilizer treatments. The highest tuber yield, grain yield of boro, T.Aus and T.Aman was obtained from the T_6 treatment where 25% additional NPK was added over the 100% STB rate in both the year. This yield was statistically similar with that produced by all the other fertilizer treatments except the native fertility treatment. Highest total rice (system) yield of 26.01 t ha^{-1} yr.$^{-1}$ was obtained from T_6 treatment. Lowest total rice (system) yield of 14.30 t ha^{-1} yr.$^{-1}$ was obtained from control i.e. native fertility treatment (T_8).

Development of Fertilizer Recommendation for Maize with Broccoli Intercropping System

An experiment was conducted at BARI Central Research Station, Gazipur and On Farm Research Division, BARI, Rangpur during the rabi season of 2016-17. The experiment was set up with nine treatments viz. T_1 (100% RDCF of Maize + 0% RDCF of Broccoli), T_2 (100% RDCF of Maize + 10% RDCF of Broccoli), T_3 (100% RDCF of Maize + 20% RDCF of Broccoli), T_4 (100% RDCF of Maize + 30% RDCF of Broccoli), T_5 (100% RDCF of Maize + 40% RDCF of Broccoli), T_6 (100% RDCF of Maize + 50% RDCF of Broccoli), T_7 (100% RDCF of Maize + 60% RDCF of Broccoli), T_8 [Sole Maize (100% RDCF of Maize with recommended spacing)] and T_9 [Sole Broccoli (100% RDCF of Broccoli with recommended spacing)]. Both brocolli and maize significantly influenced by different treatments. Average highest total system (maize) yield of 19.51 t ha^{-1} was obtained from T_7 treatment (100% RDCF of Maize + 60% RDCF of Broccoli). Economic analysis revealed that highest BCR of 3.24 was obtained from T_6 treatment (100% RDCF of Maize + 50% RDCF of Broccoli). BCR in sole brocolli and sole maize were 2.60 and 2.99, respectively.

Characterization and Utilization of Crop Residue/Agro-Industrial Waste Generated from Different Crops/Agro-Industries in Bangladesh

A study was conducted during the year of 2016-17 to find out the characterization and utilization of different crop residues/agro-industrial wastes. Crop residues are collected from rice, wheat, maize, ground nut, soybean, and sugarcane and coconut field. Agro-industrial wastes were collected from rice mill, wheat and maize flour mill, sugar mill, rice bran oil and coconut oil mill. Collected crop residue/wastes are analyzed for moisture, ash content, volatile matter content, fixed carbon content, bulk density, calorific value, carbon and nitrogen content. Crop residues/agro-industrial wastes under study were characterized by high moisture and high volatile matter content, low ash and low fixed carbon content, low bulk density, irregular shape and low energy content. Present use of crop residues/agro-industrial wastes were livestock feed, fish feed, fuel, mulching materials, soil conditioner, bedding material for animal etc. These wastes can be used for particle board, hard board, show piece for decoration and other household appliances, compost, bio gas, gasification, incineration etc.

Characterization of Solid Waste Generated from Bari Campus

A study was conducted during the month of May to June, 2016-17 to find out the characteristics of solid waste generated from BARI campus. Household solid waste are collected from 15 families of C type and 10 families of D type. Household solid waste were brought into green house of Soil Science Division and segregate to different fractions like food waste, polythene, plastic, cloth piece, paper, glass and ceramics, metals, and bones and spines. Average total waste generation is higher in C type (2.089 kg day^{-1} family^{-1}) and lower in D type (1.605 kg day^{-1} family^{-1}). Per capita waste generation rate also higher in C type ranging from 0.376 to 0.697 kg day^{-1} and lower in C type ranging from 0.185 to 0.464 kg day^{-1}. Percentage of food waste was 64.25 to 79.29% in C type and 79.44 to 81.11% in D type. In C type, generation of polythene, plastic, cloth piece, paper, glass and ceramics, metals, bones and spines were 6.97, 3.95, 1.57, 2.53, 3.99, 1.28, 1.65 and 3.76%, respectively. In D type, generation of polythene, plastic, cloth piece, paper, glass and ceramics, metals, bones and spines were 5.86, 2.90, 1.09, 2.04, 2.63, 0.72, 1.27 and 3.34%, respectively. In percent, families of D type produce more food waste than C type while families of C type produce more polythene, plastic, cloth piece, paper, glass and ceramics, metals, bones and spines. Solid waste are organic in nature which are characterized by high moisture, high organic matter and low calorific value. Food waste can be converted to organic manure through in vessel composting. Polythene, plastic, paper, cloths, metals and others waste fractions can be reused and recycled.

Liming Effect of Poultry Litter Biochar in Acidic Soil

The effectiveness of poultry litter and poultry litter biochar to ameliorate the soil acidity of an acid soil was investigated through incubation and pot experiments using lime as comparison. The soil was amended with liming materials viz. lime (1 g kg^{-1}), poultry litter (5, 10 and 15 g kg^{-1}) and poultry litter biochar (5, 10 and 15 g kg^{-1}) to observe their effect. A pot experiment was also conducted using similar treatments to observe the responses of maize crop to application of amendments. All liming materials increased soil pH and decreased soil exchangeable acidity. Application of high rate of poultry litter biochar achieved greater increase in soil pH and reduction in soil exchangeable acidity. All amendments increased one or more soil exchangeable base cations. Lime only increased soil available calcium, while poultry litter (PL) and poultry litter biochars (PLB) increased soil available Ca, Mg and K and also soil available P. Application of the amendments enhanced the uptake of one or more nutrients of N, P, K, Ca and Mg by maize in pot experiments. When PL and PLB amendments were compared, it was found that the PLB the best choice for amelioration of acid soil. The PLB achieved a greater amelioration effect on soil acidity and increased soil nutrients of Ca, Mg and K, but also enhanced the uptake of Ca, Mg, K and P by plants simultaneously.

Comparative Study on Crop Straw and Their Biochars to Increase Carbon Stock and Soil Health

Crop straws and their biochars on an acidic (rangamati region) soil were compared in incubation experiment as well as pot trial to determine the amelioration capacity of crop straw biochar and suitable organic amendments for acid soils. Six crop straws, including non-legumes (rice straw, maize straw and wheat straw) and legumes (chickpea straw and mustard straw and groundnut straw) were used to prepare biochars using a device temperature (<700°C) oxygen-limited pyrolysis method. Single application rates of 1% were used for both crop straws and their biochars in incubation experiments as well as pot trail lasting 60 days. Soil pH (1:2.5 soil to water), soil exchangeable acidity and soil exchangeable base cations were determined to evaluate the amelioration effects of these crop straws and their biochars on an acidic soil. The incorporation of crop straws increased or decreased the soil pH depending on the relative contribution of alkalinity of the straws, mineralization of organic N and nitrification of NH_4^+. The incorporation of biochars produced from crop straws increased the soil pH, and their ameliorating effects varied due to raw materials of biochars. The biochars from legume straws induced more increase in soil pH than non-legume biochars. The biochars produced from legume crop straws were better choices as amendments for acid soils than their feedstock. Organic anions and carbonates were the main forms of alkali in the biochar. The incorporation of biochar cannot only neutralize soil acidity, but can also improve soil fertility.

Effect of Vermicompost on Tomato Yield and Soil Health

An experiment was conducted at BARI Central Research Station, Gazipur, during the rabi seasons of 2015-16 and 2016-17. The experiment was set up with seven treatments viz. T_1=100% recommended dose of chemical fertilizer (RDCF), T_2=80% RDCF, T_3=60% RDCF, T_4=100% RDCF + vermicompost (VC) @ 1.5 t ha^{-1}, T_5= 80% RDCF + VC @ 3 t ha^{-1}, T_6= 60% RDCF + VC @ 6 t ha^{-1} and T_7= absolute control. Highest fruit yield of 75.4 t ha^{-1} in 2015-16 and 73.06 t ha^{-1} in 2016-17 was recorded in T_4 treatment [100% RDCF + vermicompost (VC) @ 1.5 t ha^{-1}]. Soil health was improved substantially with the application of vermicompost. The results on the growth and yield parameters of the tomato showed that the VC had the significant effect on plant height, number of fruits, length and breadth of fruit, individual fruit weight and fresh fruit yield. The highest marginal gross margin of Tk. 952965 ha^{-1} was obtained from 100% RD + 3 t ha^{-1} VC applied plot with a MBCR of 29.44. For higher production of tomato as well as improvement of soil health, 1.5 t ha^{-1} VC along with 100% RDCF can play important role. Residual effect of VC showed increased plant available nutrients in postharvest soil which improve soil health.

Integrated Nutrient Management for Malta

The experiment on integrated nutrient management for Malta was carried out at Regional Agricultural Research Station (RARS), Jamalpur to identify the suitable integration of organic manures and inorganic fertilizers. The experiment started in 2016-17 and running its first year cycle. There were seven treatments viz. T_1: 100% RD, T_2: Cowdung 5 t ha^{-1} + IPNS based inorganic fertilizer, T_3: Cowdung 10 t ha^{-1} + IPNS based inorganic fertilize, T_4: Poultry manure 5 t ha^{-1} + IPNS based inorganic fertilizer, T_5: Poultry manure 10 t ha^{-1} + IPNS based inorganic fertilizer, T_6:125% RD and T_7: control. The tested variety was BARI Malta-1. The experiment was laid out in Randomized Complete Block design (RCBD) with 5 replications. Results revealed that, T_4 treatment (Poultry manure 5 t ha^{-1} + IPNS based inorganic fertilizer) produced highest plant height (90.41 cm), base girth (1.33 cm) and canopy spreading (37.03 × 51.07 cm) and the lowest [48.00 cm, 1.13 cm and (14.67 × 14.40 cm), respectively] was found in the control treatment. Integrated use of poultry manure 5 t ha^{-1} and IPNS basis inorganic fertilizer was found as the best combination and probable of enriching the soil organic matter.

Effect of Biochar and Bioslurry on Soil Moisture Conservation and Yield of Wheat

The experiment was carried out at Regional Agricultural Research Station (RARS), Jamalpur during November, 2016 to March, 2017 to conserve soil moisture through the use of organic manure (cowdung, biochar and bioslurry) and inorganic fertilizer on wheat. There were five treatments viz. T_0 : control, T_1 : Chemical fertilizer (STB), T_2 : Chemical fertilizer + cowdung (5 t ha^{-1}), T_3 : Chemical fertilizer + biochar (5 t ha^{-1}), T_4 : Chemical fertilizer + bioslurry 5 t ha^{-1}. Among the treatments, the highest grain yield (3.83 t ha^{-1}) was obtained from biochar treated plot (T_3 treatment) which was statistically similar with T_4 (3.63 t ha^{-1}) treatment and the lowest (2.17 t ha^{-1}) from T_0 treatment. The maximum amount of soil moisture percent was found in treatment T_3 i.e. biochar treated plot and treatment T_0 i.e. control treatment contains comparatively lower percent of soil moisture.

Effect of Nitrogen and Foliar Application of Boron on Yield and Quality of Mustard

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2016-17 to know the effect of different levels of nitrogen and foliar application of boron on mustard. There were three nitrogen levels (N_1 = 90 kg N ha^{-1}, N_2 = 120 kg N ha^{-1} & N_3 = 150 kg N ha^{-1}) and four foliar applications of boron (B_1 = Foliar application of Boron in pre-flowering stage, B_2 = Foliar application of Boron in flowering stage & B_3 = Foliar application of Boron in grain filling stage). Foliar dose of Boron was 4 g $liter^{-1}$. The highest seed yield (1.54 t ha^{-1}) was recorded in N_3B_1 and lowest seed yield was 1.33 t ha^{-1} in N_1B_1. Economic analysis shows that highest gross margin (29320 Tk. ha^{-1}) as well as highest BCR (1.73) was obtained from N_3B_1 treatment (150 kg N ha^{-1} with foliar application of Boron in pre-flowering stage). The lowest level of soil salinity was recorded in sowing time (3.32 dS m^{-1}) in N_1B_2 and the highest level of salinity (10.38 dS m^{-1}) was recorded in N_1B_1 at the harvesting stage.

Effect of Different Sources of Irrigation Water on Nutrient Content and Uptake in Maize in Saline Region of Satkhira

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2016-17 to know the effect of different sources of irrigation water on nutrient content and uptake in maize. There were 4 treatments viz. T_1 = Surface water, T_2 = Underground water, T_3 = River water and T_4 = Underground water and river water (1:1). The highest grain yield was (11.68 t ha^{-1}) recorded in T_2 and lowest was (8.82 t ha^{-1}) in T_3. Highest level of MBCR (3.81) was recorded in T_4. Soil and water salinity range of T_1, T_2, T_3 and T_4 were 3.32-10.16 and 2.05-6.22, 3.28-8.05 and 1.92-5.92, 3.34-12.22 and 3.55-14.22, and 3.36-9.45 and 2.72-9.69 dS/m, respectively.

Effect of Mulching and Fertilizers on Soil Salinity and Mustard Yield in Coastal Saline Soils of Bangladesh

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during the rabi season of 2016-17 to investigate the effect of mulching and different rates of fertilizer on mustard yield under saline soil. There were nine treatments: T_1 = Recommended Dose of Fertilizer (RDF), T_2 = Rice straw 5 t ha^{-1} + 100% RDF, T_3 = Rice straw 5 t ha^{-1} + 75% RDF, T_4 = Rice straw 2 t ha^{-1} + 100% RDF, T_5 = Rice straw 2 t ha^{-1} + 75% RDF, T_6 = Wheat straw 5 t ha^{-1} + 100% RDF, T_7 = Wheat straw 5 t ha^{-1} + 75% RDF, T_8 = Wheat straw 2 t ha^{-1} + 100% RDF and T_9 = Wheat straw 2 t ha^{-1} + 75% RDF. The highest seed yield (1.50 t ha^{-1}) of mustard was recorded in T_2 and lowest seed yield was (1.12 t ha^{-1}) was in T_1. Highest gross return (67500 Tk. ha^{-1}) was obtained from T_2 treatment. Highest BCR of 1.66 and 1.67 were obtained from T_5 (Rice straw 2 t ha^{-1} + 75% RDF) and T_9 (Wheat straw 2 t ha^{-1} + 75% RDF) treatment, respectively. The lowest level of soil salinity was recorded in sowing time (3.30 ds m^{-1}) in T_5 and the highest level of salinity (10.48 ds m^{-1}) was recorded in T_1 at the harvesting stage.

Effect of Chemical Fertilizer, Cowdung and Poultry Manure on the Yield of Tomato in the Southern Region of Bangladesh

A field experiment was conducted at Regional Agricultural Research Station, Rahmatpur, Barisal during the *rabi* season of 2016-17 to evaluate the efficiency ofcowdung and/or poultry manure on growth and yield of tomato. The crop variety was BARI Tomato-14. There were seven treatments viz. T_1: Control, T_2: 100% recommanded dose (RD), T_3: 75% RD, T_4: 100% RD + cowdung @ 5 t ha^{-1}, T_5: 100% RD + poultry manure @ 3 t ha^{-1}, T_6: 75% RD + cowdung @ 5 t ha^{-1}, T_7: 75% RD + poulty manure @ 3 t ha^{-1} which were replicated four times. Cowdung, poultry manure along with chemical fertilizers had significant influence on plant height (cm), no of cluster $plant^{-1}$, fruit diameter (mm), fruit volume (cm^3), fruit yield (t ha^{-1}) of tomato. Significantly higher fruit yield (65.2 t ha^{-1}) was recorded with 100% RD pluscowdung 5 t ha^{-1}. The treatments 100% RD + poultry manure @ 3 t ha^{-1}, 75% RD + cowdung @ 5 t ha^{-1}, 75% RD + poulty manure @ 3 t ha^{-1} were recorded identical fruit yield with 100% RD + cowdung @ 5 t ha^{-1}. Therefore, 25% RD fertilizer could be reduced when in tegrated use of cowdung and/or poultry manure in tomatocultivation in southwestern region, Barisal (Non–calcareous Grey Floodplain Soils under AEZ 13).

Integrated Nutrient Management for Sustaining Soil Fertility and Production of Wheat-Mungbean-T.Aman Cropping Pattern at Jessore

A long term field experiment on Wheat-Mungbean-T.aman cropping pattern has been carried out in High Ganges Floodplain Soils (AEZ-11) of RARS, Jessore from 2000-2016. The objectives were to find out sustainable fertilizer recommendations, monitor soil health, estimate uptake of different nutrient for the cropping pattern & to make a balance sheet for each of the nutrient. There were six treatments viz. 125% recommended dose (RD), 100% RD, 75% RD, 50% RD, farmers practice and native nutrient. The design was RCBD with three replications. Results showed consistently highest yield from each of the crops of the pattern obtained with 125% RD treatment and which were statistically similar to 100% RD treatment. Highest total rice (system) yield of 12.74 t ha^{-1} $year^{-1}$ was obtained from T_1 treatment (125% RD). Lowest total rice (system) yield of 6.89 t ha^{-1} $year^{-1}$ was obtained from control i.e. native fertility treatment (T_6). Highest gross margin of 113957 Tk. ha^{-1} $yr.^{-1}$ was also obtained from T_1 treatment (125% RD). The highest benefit cost ratio of 1.80 was found in T_1 (125% RD) and T_2 treatment (100% RD).

Nutrient Management for Sustaining Soil Fertility and Performance of Mustard-Mungbean-T.Aman Cropping Pattern at Jessore

A long term field trial on Mustard-Mungbean-T.aman cropping pattern has been conducted from 2000-16 in High Ganges Floodplain Soils (AEZ-11) of Jessore. The objectives were to find out sustainable fertilizer doses for the pattern, monitor soil health, estimate uptake of different nutrients and make a balance sheet for each of the nutrient. There were three levels each of N (80, 120 and 160 kg ha^{-1}), P (18, 36 and 54 kg ha^{-1}) and K (35, 70 and 105 kg ha^{-1}) in the treatment combinations. The design was RCB replicated thrice. The combined effect of 120-54-70-40-3-1 kg ha^{-1} of NPKSZnB (T_5) produced the highest seed yield (1.50 t ha^{-1}) of mustard. The residual effect of 120-54-70-40-3-1 kg ha^{-1} of NPKSZnB (T_5) gave the highest yield of both grain and straw yield of mungbean and T.aman rice. Highest total rice (system) yield of 14.71 t ha^{-1} year^{-1} was obtained from T_5 treatment. Lowest total rice (system) yield of 8.63 t ha^{-1} year^{-1} was obtained from control i.e. native fertility treatment (T_8). Highest gross margin of 133510 Tk. ha^{-1} yr.$^{-1}$ and BCR of 1.83 obtained from T_5 treatment. It was observed that a total amount of 1345.9, 285.3, 1242, 210.7 and 10.6 kg ha^{-1} of NPKS and Zn were removed from the soil by fifteen cropping cycles while 1300, 540, 700, 250, and 15 kg ha^{-1} of NPKS and Zn were added in the soil as nutrients. N and K removal were found to be higher than the amount added. About 250, 38, 280, 32 and 1 kg ha^{-1} of NPKS and Zn were added in soil system when about 52 t ha^{-1} of green biomass of mungbean from fifteen cropping cycles were ploughed down after grain harvest.

Micronutrient Aspects of Soil Management

Effect of Vermicompost on Micronutrient Availability and Carbon Accumulation in Soils

Field trial was conducted with cabbage ‘Atlas-70’ during *rabi* season of 2016-17 at the Bangladesh Agricultural Research Institute (BARI), Gazipur (24° 00′ N, 90° 25′ E and 8.4 m elv) (AEZ-28) to quantify the effect of vermicompost (VC) on Cu, Fe, Mn, Zn and B availability and. There were six treatments replicated thrice where VC and composted farmyard manure (FYM) were used as the organic sources. Different nutrient packages significantly influenced the yield and yield components of cabbage. The highest cabbage head yield (94.4 t ha^{-1}) was obtained with VC @ 5 t ha^{-1} + IPNS (Integrated Plant Nutrient System) basis RDCF (Recommended Dose of Chemical Fertilizer) application. This yield was statistically identical with the treatment where FYM was applied @ 5 t ha^{-1} + IPNS basis RDCF (87.3 t ha^{-1}). The lowest yield (28.59 t ha^{-1}) was observed in control treatment. Vermicompost exhibited better performance than FYM in combination with chemical fertilizer. The enhanced yield of cabbage in this study can be partially explained by the elevated levels of macro and micro nutrients contents in VC. Vermicompost and FYM application improved soil micronutrients availability. The translocation factor (TF) pattern in the present study is B>Cu>Zn>Fe>Mn. Soil organic carbon status in post harvest soil showed slightly increasing trend where organic materials were used compared to inorganic fertilizer. Among the organic materials, carbon accumulation is more in VC treated plots (1.5 to 1.9 t ha^{-1}) followed by FYM (1.2 to 1.6 t ha^{-1}). It is suggested that VC @ 5.0 t ha^{-1} + IPNS basis RDCF is more favorable for higher head yield of cabbage and suitable for soil health for micronutrients availability and soil carbon accumulation in the study area of Grey Terrace Soil of Gazipur (AEZ-28).

Heavy Metal Content in Different Vegetables Grown in Industrially Polluted and Non-Polluted Areas

The content of four toxic heavy metals, lead (Pb), cadmium (Cd), nickel (Ni), and chromium (Cr) in three vegetables namely radish (Raphanus sativus), potato (Solanum tuberosum), and turnip (Brassica rapa) and in the rhizosphere soils of the respective crops from two locations viz, waste water-irrigated and clean water-irrigated areas were assessed using atomic absorption spectrophotometer. Regardless of locations, there were significant differences ($P < 0.05$) in the average Pb, Cd, Ni, and Cr concentrations in different vegetables species and the soils in which they were grown. The accumulation of metal in the plants was two to four folds higher at waste water-irrigated site compared to concentrations were recorded at clean water-irrigated site. The mean value of metals content in the roots and shoots ranged from 0.075 to 0.097, 0.052 to 0.0.085, 14.6 to 33.5, and 24.4 to 28.4 µg g^{-1}, respectively in Pb, Cd, Ni and Cr in waste water-irrigated site and it was 0.024 to 0.037, 0.026 to 0.038, 5.34 to 16.3, and 11.3 to 17.2 µg g^{-1} for clean water-irrigated site. Results of the study show that among the three spices, the maximum concentration of Pb, Cd, Ni and Cr was found in turnip. The concentrations of metal in plants followed the rules that Ni > Cr > Pb > Cd. In soil, the concentration of Pb, Ni and Cr not exceeding the maximum permissible limit 100, 50 and 100 µg g^{-1}, respectively at both the sites but Cd exceeding the maximum permissible limit. In plant, the concentration of Pb and Cd not exceeding the maximum permissible limit 5 and 0.3 µg g^{-1}, respectively for food and food stuff provided by FAO/WHO at both the sites but Ni and Cr exceeds the maximum permissible limit. Therefore, soil is said to be alarming to contaminate by anthropogenic inputs and requires continuous monitoring of this area.

Remediation of Heavy Metals Polluted Soil from Industrial Effluents Polluted Areas Through Organic and Inorganic Amendments

This study was conducted to determine the effects of organic and inorganic materials to remediate contaminated soil with heavy metals. A pot study was performed by growing Maize (Zea mays) in metal contaminated soil (10 kg pot^{-1}) and soils amendments with red soil, bamboo charcoal/Ash, compost, iron and lime each at 5 g kg^{-1} soil. The results showed that Pb, Cd, Ni, and Cr uptake by maize depended on the materials type. Application of organic and inorganic materials has been shown to immobilize metals in soil and decreased the metal content of plants. Compost, lime and bamboo charcoal/Ash had significant impact on immobilization or phytoextraction of metal from soil. The percentage (%) of metal uptake decreased in maize with addition of organic and inorganic material compared with contaminated control were Pb-16.2 to 62.3, Cd-11.6 to 35.0, Ni-6.11 to 23.5 and Cr-3.54 to 55.1. Addition of organic and inorganic materials to contaminated soil did not totally restrict the uptake of metal by maize plants. Red soil, bamboo charcoal/Ash, compost, iron and lime addition led to decreased metal content in maize, and this decrease was better expressed with 12.0 to 17.7% for red soil, 35.0 to 40.8 % for bamboo charcoal/Ash, 35.0 to 44.5% for compost, 3.94 to 16.2% for iron and 45.3 to 48.0% for lime. The different effectiveness of amendment on heavy metal uptake by maize plant could be due to the nature and type of amendment. However, immobilization or phytoextraction techniques might be used to remediate soil which contaminated with heavy metal.

Remediation of Arsenic in Contaminated Soils Using Organic and Inorganic Amendments

A pot experiment was carried out in the micronutrient experimental field of Soil Science Division of the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur on January 2017 to determine the effects of organic and inorganic materials to remediate contaminated soil with Arsenic (As). Arsenic was added to the pots at the rates of 4000 µg kg^{-1} and in metal contaminated soils (10 kg pot^{-1}) amendments with red soil, bamboo charcoal/Ash, compost, iron oxide and lime each at 5 g kg^{-1} soil. Addition of organic and inorganic materials to contaminated soil did not totally restrict the uptake of As by maize plants. Red soil, bamboo charcoal/Ash, compost, iron oxide and lime addition led to decreased metal content in maize, and this decrease was better expressed with 4.24% for red soil, 6.67 % for bamboo charcoal/Ash, 29.7% for compost, 26.1% for iron oxide and 16.7% for lime. In maize plants for the highest As concentration in red soil treatment was found to be 85% in root and 15% in shoot; whereas in compost treatment, 92% was in the root and 8% in shoot. The present findings suggest that compost and Fe-oxide may be used as effective amendments to attenuate As in soils by reducing its bioavailability.

Effectiveness of Soil and Foliar Applications of Zinc and Boron on the Yield of Sweet Pepper

A field experiment was carried out to study the effectiveness of soil and foliar application of micronutrients on the yield of sweet pepper (Capsicum annuum L.) at Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, located at 23º59′18″ N and 90º24′37″ E. The micronutrients zinc (Zn) in the form of zincsulphate ($ZnSO_4.7H_2O$) as zinc source at the rate of 0.05 % and and boron (B) in the form of boric acid (H_3BO_3) at the rate of 0.03% were applied as foliar spray at three different stages of plant growth i.e (i) before flower initiation; (ii) after fruit set when it becomes approximately marble sized; and (iii) after 20 days of second spray. The sweet pepper yield and its contributing yield traits were significantly affected by foliar fertilizer treatments as against soil application of B and Zn fertilizers. Among various treatments, foliar application of Zn (0.05 %) + B

(0.03%) produced maximum fruit yield (24.6 t ha^{-1}) while the control no use of Zn (0.0) and B (0.0) produced minimum (17.2 t ha^{-1}) and it was statistically differed with soil application of B and Zn @ 2 and 6 kg ha^{-1} (T_5). The increment of yield was 7.03 to 43.3% and 4.46 to 12.5%, respectively, over control and soil application.

Zinc-Iron Relationship in Wheat Plant Grown Under Drought Stress Condition

A field experiment was carried out to study the zinc-iron relationship in wheat (BARI gom-26) plant grown under water stress condition at Soil Science Division, BARI, Joydebpur, Gazipur, during December 2016 to April 2017. The experiment was designed in a split plot on sixteen treatments comprising four irrigation treatments (regular irrigation, stopping irrigation at crown root initiation, stopping irrigation at booting stage and stopping irrigation at grain filling stage) and four foliar application of zinc and iron (control, 0.05% of zinc, 0.05% of iron and 0.05% of zinc +0.05% of iron). Zinc Sulphate Monohydrate ($ZnSO_4$. H_2O) and ferrous sulphate ($FeSO_4$ .H_2O) was used as a source of Zn and Fe. The highest yield (3.91 t ha^{-1}) was recorded in stopping irrigation at grain filling stage which was identical with regular irrigation. Water stress at crown root initiation stage had the most negative effect on growth and yield. Foliar application of zinc and iron played a major role on yield and yield components of wheat at later stages of growth. The results obtained from the present research showed that iron and zinc spray developed grain yield and quality of wheat and improved the effects caused by drought stress.

Effect of Boron on Flower, Fruit Set and Yield of BARI Bt Brinjal-2

A field experiment was carried out to study the effect of boron on flower, fruit set and yield of Bt brinjal at Soil Science Division, BARI, Gazipur. Design of the experiment was RCB with 3 (three) replications. The micronutrient boron (B) in the form of boric acid (H_3BO_3) having 18% boron were applied at full bloom and other two were given at an interval of 10 days. The treatment combinations of foliar spray of boron were T_1:50 ppm B, T_2:100 ppm B, T_3:150 ppm B and T_4: control. The yield and yield contributing character of bt brinjal were significantly affected by foliar application of boron. All parameters showed higher tendency in T_1 treatment. The highest yield (15.2 t ha^{-1}) was observed in 50 ppm foliar application of boron and it was significantly higher with untreated plants. Foliar application of boron is effective on flower, fruit set and yield of Bt brinjal.

Effect of Boron Application on Recently Released Wheat Varieties of Bangladesh

A pot experiment was carried out at the Net house of Soil Science Division of the Bangladesh Agricultural Research Institute (BARI), Gazipur during Rabi season, 2016-17 with soils of non-calcareous floodplain soil (AEZ-3). The objectives were to evaluate the effect of boron on the yield of wheat, estimate boron use efficiency and to find out suitable variety tested against different boron levels for maximizing yield. The experiment was designed in Completely Randomized Design (CRD) with three replications. Three varieties of wheat (BARI Gom 28, BARI Gom 29 and BARI Gom 30) with 5 levels of boron (0, 0.5, 1.0, 1.5 and 2 kg ha^{-1}) along with a blanket dose $N_{120}P_{30}K_{90}S_{15}Zn_3Mg_6$ kg ha^{-1} were used in the study. All the three varieties were performed better with application of 1.5 kg B ha^{-1} as compared to the other treatment combinations. However, higher yield (47.72 g pot^{-1}) was obtained in BARI Gom 30 variety @ 1.5 kg B ha^{-1} application.

Determination of Critical Limit of Zinc for Maize Crop

A pot experiment was conducted at the net house of Soil Science Division of Bangladesh Agricultural Research Institute to determine the critical limit of zinc (Zn) for maize grown in 20 soils collected from the five AEZs such as Tista Meander Floodplain (AEZ-3), Karatoya –Bangali Floodplain (AEZ-4), High Ganges River Floodplain (AEZ-11), Low Ganges River Floodplain (AEZ-12) and Madhupur Tract (AEZ-28) during *rabi* season of 2016-17. The soils contained pH 5.41-7.99, organic matter .46-1.97%. The available Zn content of soils was estimated by one extraction method as 0.005 M DTPA.

The critical level of DTPA extractable Zn was found to be 0.87 for maize cropping as determined by Cate and Nelson's graphical procedure.

Microbiological Aspects of Soil Management

Assessment of Arbuscular Mycorrhizal Association in Some Fruit and Spices Plants

Rhizosphere soils of some fruit and spices plants from Agricultural Research Station, Daulatpur, Khulna and Regional Horticultural Research Station, Patuakhali during 2015-16 and 2016-17, and Regional Horticultural Research Station, Chapainawabgonj during 2016-17 for counting AM spore population and determining colonization (%) in their roots. At Khulna, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 76.3 (Jamrul) to a maximum of 200.0 (Bilimbi) during 2015-16 and from 69.0 (Aam) to a maximum of 181.7 (Tetul) during 2016-17. At Patuakhali, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 63.7 (Litchu) to a maximum of 222.0 (Amlaki) during 2015-16 and from 48.3 (Pepey) to a maximum of 533.3 (Cherryfal) during 2016-17. At Chapainawabgonj, the spore numbers of 100 gram rhizosphere soil were recorded ranging from 71.0 (Bael) to a maximum of 137.7 (Sajna) during 2016-17. A considerable variation was observed in average spore numbers recorded in different friut and spices plants. Different fruit plants showed different percentages of root colonization by AM fungi. At Khulna, among all the fruit and spices plants, the highest root colonization (30.0%) was found in Supari and the lowest colonization (10.0%) was found in Kola, Kul, Malta, Sajna and Tejpata during 2015-16 and the highest root colonization (30.0%) was found in Amra, Bael, Kul, Lithu and the lowest colonization (10.0%) was found in Kola, Malta, Sajna, Supari and Tejpata during 2016-17. At Patuakhali, among all the fruit and spices plants, the highest colonization (30.0%) was found in Amra, Cherryfal and Kul, and the lowest colonization (10.0%) was found in Litchu, Malta, Narikel and Tetul during 2015-16, and the highest colonization (30.0%) was found in Amra, Jalpai, Katabohori and Kul, and the lowest colonization (10.0%) was found in Tetul. At Chapainawabgonj, higher root colonization (30.0%) was found in Narikel and lower colonization (10.0%) was found in all other plants during 2016-17.

Collection, Isolation and Screening of Indigenous Rhizobial Strains for Different Legumes

Nodules were collected from different legume crops grown under different locations in Bangladesh during 2016-17. Nine legume crops namely grasspea, lentil, chickpea, mungbean, gardenpea, groundnut, soybean, frenchbean and motor were selected for collecting nodules from 9 different locations. Grasspea from two, lentil from three, chickpea from one, mungbean from one, gardenpea from four, groundnut from five, soybean from two, frenchbean from two and motor from one locations. These collected nodules were crushed, isolated and screened in the microbiology laboratory. Screening of some strains are going on.

Collection and Assessment of Arbuscular Mycorrhizal Fungi in Different Field Crops

A total of 24 crop samples from 12 crops covering 2 AEZs (AEZ-11 and 18) were collected and assessed during 2016-17 for determining root colonization (%) and spore population ($100g^{-1}$ soil) of AM fungi. Gardenpea and potato showed the highest root colonization (30.0%) in AEZ-11 (Jessore) and motor (30.0%) in AEZ-11 (Ishurdi). But the highest number of spores (188.0 $100g^{-1}$ soil) was found with soybean in AEZ-18 (Rahmatpur).

Study on *Rhizobium*, *Azotobacter* and Phosphate Solubilizing Bacterial (PSB) Population Status in Soils of Different AEZS of Bangladesh

Rhizobium plays a major role in legumes to supply nitrogen through symbiotic nitrogen fixation. Fifteen soil samples were collected from selected locations of different AEZs of Bangladesh to know the *Rhizobium* population at different AEZs (5 AEZs) of Bangladesh. Soil samples were collected from BARI Central Farm (AEZ-28), RARS, Jamalpur (AEZ-09), RARS, Jessore (AEZ-11); RARS, Ishurdi (AEZ-11); Farmer's field, Norail (AEZ-12); Farmer's field, Faridpur (AEZ-12); Farmer's field, Pabna (AEZ-11); Farmer's field, Chuadanga (AEZ-11); RHRS, Chapainawabgonj (Fruit plants)

(AEZ-11); RHRS, Patuakhali (Fruit plants) (AEZ-13); ARS, Khulna (Fruit plants) (AEZ-13). *Rhizobium* was grown in media and *Rhizobium* colonies were counted. The highest *Rhizobium* population (1.5×10^6 g^{-1} soil) was found in soils of RARS, Jamalpur (Groundnut expt.) (AEZ-09) and and the lowest population (5.0×10^3 g^{-1} soil) was observed in soils of RHRS, Patuakhali (Fruit plants) (AEZ-13).

Decomposition Characteristics of Different Organic Materials under Different Soils and Region

Field incubation experiments were conducted at Central Research Farm of BARI, Joydebpur; Regional Agricultural Research Station, Jessore and Wheat Research Centre, Nashipur, Dinajpur during 2015-16 to estimate the decomposition rate of different organic materials. There were eight treatments like T_1: Rice straw, T_2: Corn straw, T_3: Wheat straw, T_4: Cowdung, T_5: Cowdung slurry, T_6: Poultry manure, T_7: Poultry manure slurry and T_8: Vermicompost. Nylon mesh bag (0.075mm mesh size) was used in this incubation experiment. Organic materials containing mesh bag were placed horizontally in 10-12 cm soil depth. The nylon mesh bags were collected from the field during different period of time. The mass loss of organic materials were calculated over period of incubation and the decomposition rates (k) were estimated from their remaining C by fitting a single-pool exponential decay model over time of field incubation. Highest mass loss was occurred in crop straw and lowest in manure slurry and animal manure showed the intermediate loss. In case of C decomposition the highest decomposition rate was observed in corn straw at all the three locations where manure and manure slurry showed lower decomposition during the 12 month period of decompositions.

Suitability Study of Biochar as an Alternate Carrier to Peat for the Preparation of *Rhizobium* Biofertilizers

A laboratory experiment was carried out in the Soil Microbiology Laboratory of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2015-16 and 2016-17 to find out the suitable carrier materials for *Rhizobium* biofertilizer production as an alternate to peat. There were seven treatments viz. T_1: Rice straw based biochar, T_2: Grass based biochar, T_3: Sawdust based biochar, T_4: Groundnut straw based biochar, T_5: Mimosa based biochar, T_6: Chickpea straw based biochar and T_7: Peat. BARI RGm-901 (a *Rhizobium* strain isolated for soybean, *Glycine max* L.) was selected as a *Rhizobium* strain for this experiment. In 2016-17, among the different carriers, peat based inoculum recorded a maximum population of 7.5×10^8 cfu g^{-1} at 45 days after inoculation followed by rice straw based biochar of 4.0×10^8 cfu g^{-1} of carrier and sawdust based biochar of 2.0×10^8 cfu g^{-1} of carrier. In addition, it was observed that all the carrier materials performed better at low temperature storage condition compared to room temperature.

Effect of Biofertilizer, Vermicompost and Chemical Fertilizers on Bushbean

A field experiment was conducted at Central Farm, Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Rahmatpur, Barisal to evaluate the effect of Rhizobium biofertilizer, vermicompost and chemical fertilizers on bushbean during the rabi season of 2015-16 and 2016-17. The crop variety was BARI Jharseem-1 and *Rhizobium* strain was BARI RPv-702. There were nine treatments viz. T_1: Control, T_2: Vermicompost (VC) @ 2.5 t ha^{-1}, T_3: VC @ 5.0 t ha^{-1}, T_4: VC @ 2.5 t ha^{-1} + Integrated Plant Nutrient System (IPNS) based NPKSZnB, T_5: VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB, T_6: VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_7: VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_8: 100%NPKSZnB, T_9: *Rhizobium* + 100%PKSZnB which were replicated four times. Peat based rhizobial inoculum was used at the rate of 1.5 kg ha^{-1} as seed inoculant. The *Rhizobium* inoculated bushbean with VC 5.0 t ha^{-1} and IPNS based PKSZnB increased nodule number (14.8 nodules $plant^{-1}$ in 2016 and 16.79 nodules $plant^{-1}$ in 2017), nodule weight (22.9 mg $plant^{-1}$ in 2016 and 24.9 mg $plant^{-1}$ in 2017) and plant height (34.1 cm in 2016 and 30.4 cm in 2017). It was observed that VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB fertilizers produced the highest pod yield (16.8 pod $plant^{-1}$ in 2016 and 16.3 pod $plant^{-1}$ in 2017), stover yield (3.9 t ha^{-1} in

2016 and 4.05 t ha^{-1} in 2017), green pod yield (15.8 t ha^{-1}, 83.7% higher over control in 2016 and 16.3 t ha^{-1}, 154% higher over control in 2017) and seed yield (1.83 t ha^{-1}, 123% higher over control in 2016, and 1.81 t ha^{-1}, 135% higher over control in 2017) of bushbean. This green pod yield of T_7 treatment was statistically identical with all other treatments except control treatment, VC @ 2.5 t ha^{-1} and VC @ 5.0 t ha^{-1} in 2016 and same treatments differ with all other treatments except VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB in 2017. The dry seed yield of T_7 treatment was identical with VC @ 2.5 t ha^{-1} + IPNS based NPKSZnB, VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB, VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB and VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB but differed from other treatments in 2016, and same treatment identical with VC @ 2.5 t ha^{-1} + IPNS based NPKSZnB, VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB, VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB and VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, 100%NPKSZnB but differed from other treatments in 2017. This indicates that application of vermicompost @ 5.0 t ha^{-1} plus *Rhizobium* can reduce a considerable amount of chemical fertilizers. Vermicompost exhibited better performance in bushbean. To improve soil health and to maintain it as well as to improve crop production, we have to reduce chemical fertilizer. It can be concluded that VC 5.0 t ha^{-1} and *Rhizobium* along with IPNS based chemical fertilizers except N may be recommended for bushbean cultivation in southwestern region, Barisal (Non–calcareous Grey Floodplain Soils under AEZ 13).

Effect of Biofertilizer, Vermicompost and Chemical Fertilizers on Gardenpea

A field experiment was conducted at Central Farm, Regional Agricultural Research Station, Rahmatpur, Barisal to evaluate the effect of *Rhizobium* biofertilizer, vermicompost and chemical fertilizers on gardenpea during the *rabi* season of 2015-16 and 2016-17. The crop variety was BARI Motoshuti-3 and *Rhizobium* (R) strain was BARI RPs-501. There were nine treatments viz. T_1: Control, T_2: Vermicompost (VC) @ 2.5 t ha^{-1}, T_3: VC @ 5.0 t ha^{-1}, T_4: VC @ 2.5 t ha^{-1} + Integrated Plant Nutrient System (IPNS) based NPKSZnB, T_5: VC @ 5.0 t ha^{-1} + IPNS based NPKSZnB, T_6: VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_7: VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB, T_8: 100%NPKSZnB, T_9: *Rhizobium* + 100%PKSZnB which were replicated four times. Peat based rhizobial inoculum was used at the rate of 1.5 kg ha^{-1} as seed inoculant. The *Rhizobium* inoculated gardenpea with VC 5.0 t ha^{-1} and IPNS based PKSZnB increased nodule number (206.5 nodules plant^{-1} in 2016 and 146.5 nodules plant^{-1} in 2017), nodule weight (48.3 mg plant^{-1} in 2016 and 45.8 mg plant^{-1} in 2017), shoot weight (25.5 g plant^{-1} in 2016 and 24.5 g plant^{-1} in 2017) and root weight (0.95 g plant^{-1} in 2016 and 0.68 g plant^{-1} in 2017). It was observed that VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKSZnB fertilizers produced the highest pod yield (8.69 pod plant^{-1} in 2016 and 11.4 pod plant^{-1} in 2017), stover yield (2.91t ha^{-1} in 2016 and 2.75 t ha^{-1} in 2017), green pod yield (11.2 t ha^{-1}, 67.2% higher over control in 2016 and 9.88 t ha^{-1}, 119.5% higher over control in 2017) and seed yield (1.92 t ha^{-1}, 72.7% higher over control in 2016, and 1.73 t ha^{-1}, 130.7% higher over control in 2017) of gardenpea. This green pod yield was statistically identical with T_4, T_5, T_6 and T_9 treatments and seed yield was statistically identical with T_4 and T_5 treatments in 2016. Similarly, this green pod yield was statistically identical with T_5 treatment and seed yield was statistically identical with T_5, T_6 and T_9 treatments in 2017. This indicates that application of vermicompost @ 5.0 t ha^{-1} plus *Rhizobium* can reduce a considerable amount of chemical fertilizers. Vermicompost exhibited better performance in gardenpea. To improve soil health and to maintain it as well as to improve crop production, we have to reduce chemical fertilizer. Therefore, VC 5.0 t ha^{-1} and *Rhizobium* along with IPNS based chemical fertilizers except N may be recommended for gardenpea cultivation for rich conscious farmers. From the economic point of view, the yield was higher in T_9 treatment; poor farmers can adopt this treatment. From the trial, it can be concluded that full doses of chemical fertilizers and *Rhizobium* along with IPNS based chemical fertilizers (except N) may be recommended for gardenpea cultivation in southwestern region, Barisal (Non–calcareous Grey Floodplain Soils under AEZ 13).

Effect of Biofertilizer, Vermicompost and Chemical Fertilizers on Groundnut

A field experiment was conducted at RARS, Rahmatpur, Barisal to evaluate the effect of *Rhizobium* biofertilizer, vermicompost and chemical fertilizers on groundnut during the *rabi* season of 2015-16 and 2016-17. The crop variety was BARI Chinabadam-8 and *Bradyrhizobium* strain was BARI RAh-892. There were nine treatments viz. T_1: Control, T_2: Vermicompost (VC) @ 2.5 t ha^{-1}, T_3: VC @ 5 t ha^{-1}, T_4: VC @ 2.5 t ha^{-1} + Integrated Plant Nutrient System (IPNS) based NPKSZnB, T_5: VC @ 5 t ha^{-1} + IPNS based NPKSZnB, T_6: VC @ 2.5 t ha^{-1} + *Bradyrhizobium* + IPNS based PKSZnB, T_7: VC @ 5 t ha^{-1} + *Bradyrhizobium* + IPNS based PKSZnB, T_8: 100% NPKSZnB, T_9: *Bradyrhizobium* + 100% PKSZnB which were replicated four times. Peat based rhizobial inoculum was used at the rate of 1.5 kg ha^{-1} as seed inoculant. *Bradyrhizobium* inoculated groundnut with vermicompost @ 5 t ha^{-1} and IPNS based PKSZnB increased nodule number (156.8 $plant^{-1}$ in 2016 and 174.3 $plant^{-1}$ in 2017), nodule weight (0.30 g $plant^{-1}$ in 2016 and 0.64 g $plant^{-1}$ in 2017) and shoot weight (63.72 g $plant^{-1}$ in 2016 and 71.1 g $plant^{-1}$ in 2017) and root weight (2.78 g $plant^{-1}$ in 2016 and 2.91 g $plant^{-1}$ in 2017). It was observed that the same treatment produced the highest nut yield (2.41 t ha^{-1}, 58.6% higher over control in 2016, and 2.51 t ha^{-1}, 71.9% higher over control in 2017) of groundnut which was differ with all other treatment except T_5 and T_6 treatments in 2016, and identical with all other treatments except T_1, T_2, T_3, T_4 and T_8 treatments in 2017. This indicates that application of vermicompost @ 5.0 t ha^{-1} plus *Bradyrhizobium* inoculant can reduce a considerable amount of chemical fertlilizers. Vermicompost exhibited better performance in groundnut. To improve soil health and to maintain it as well as to improve crop production, we have to reduce chemical fertilizer. From the trial, it can be concluded that vermicompost @ 5 t ha^{-1} plus *Bradyrhizobium* inoculant along with IPNS based chemical fertilizers except N may be recommended for groundnut cultivation in Non–Calcareous Grey Floodplain Soils of Barisal (AEZ-13). Further studies at different AEZs and economic analysis are required for final recommendation.

Effect of Arbuscular Mycorrhizal Fungi and Phosphorus on Onion

A field experiment was conducted at Central Farm, Regional Spices Research Center, Magura during rabi season of 2015-16 and 2016-17 with the objectives to study the effect of combined use of arbuscular mycorrhizal fungi and phosphorus on growth and yield of onion, and to reduce to use of P-fertilizer under field condition. The experiment was designed in factorial RCBD with six treatments and four replications. The onion variety was BARI Piaj-1 as test crop. Soil based arbuscular mycorrhizal (AM) inoculum and infected root pieces of the host plant were used at the rate of 1 kg soil m^{-2} in seedbed for producing onion seedlings. The treatment combinations were: T_1P_1U: 0% P X Without AM, T_2P_2U: 50% P X Without AM, T_3P_3U: 100% P X Without AM, T_4P_1AM: 0% P X With AM, T_5P_2AM: 50% P X With AM, T_6P_3AM: 100% P X With AM. Mycorrhizal inoculation significantly increased number of leaves ($plant^{-1}$), root length (cm) root colonization (%), spore population (100 g^{-1} soil), biomass yield (t ha^{-1}) and bulb yield (t ha^{-1}). Plant height (cm), collar diameter (cm) bulb volume and weight were non-significant. The plant that received AM in nursery bed produced higher bulb yield than without AM in all phosphorus levels for onion. The highest onion yield (11.4 t ha^{-1} in 2016, 34.4% higher over control and 11.9 t ha^{-1} in 2017, 48% higher over control) was recorded in 50% P with AM (AM was used in nursery bed). The result indicates that inoculation of AM used in nursery bed can save 50% P in the field. The plant which did not receive AM in nursery bed produced lower yield in all phosphorus levels in the field. Further study in P deficient soil and economic analysis is required for final recommendation.

Effect of Arbuscular Mycorrhizal Fungi and Phosphorus on Tomato

A field experiment was conducted at Central Farm, Regional Agricultural Research Station, Jessore on 10 December 2015 and 05 December 2016 on tomato with the objectives to study the effect of combined use of arbuscular mycorrhiza and phosphorus on tomato and to reduce to use of P-fertilizer under field condition. The experiment was designed in factorial RCBD with six treatments and four replications. The tomato variety was BARI Tomato-15 as test crop. Soil based arbuscular mycorrhizal (AM) inoculum was used in seed bed for this experiment containing about 100 spores per 100 g soil and infected root pieces of the host plant which was used at the rate of 1 kg soil inoculum m^{-2}. The treatment combinations were: T_1P_1U: 0% P × Without AM, T_2P_2U: 50% P × Without AM, T_3P_3U: 100% P × Without AM, T_4P_1AM: 0% P × With AM, T_5P_2AM: 50% P × With AM, T_6P_3AM: 100% P × With AM. Mycorrhizal inoculation increased plant height (cm), collar diameter (cm), root length (cm), shoot dry weight (g), root dry weight (g), root colonization (%), spore population ($100g^{-1}$ soil), number of fruit $plant^{-1}$, fruit length (cm), fruit diameter (cm), fruit volume (cm^3), individual fruit weight (g $fruit^{-1}$), fruit yield (kg $plan^{-1}$) and fruit yield (t ha^{-1}) of tomato compared to without AM plant. The plant that received AM in nursery bed produced higher yield than without AM in all phosphorus levels. The highest tomato yield 43.7 t ha^{-1} was recorded in 50% P plus AM in 2016 and yield 78.8 t ha^{-1} was recorded in 100% P plus AM in 2017 (AM was used in nursery bed). AM inoculated plant with 50% P gave 43.7 t ha^{-1} yield of tomato while non-AM inoculated with 100% P gave 36.8 t ha^{-1} yield which indicate that inoculation of AM used in nursery bed can save 50% P in the field in 2016. AM inoculated plant with 50% P gave 77.3 t ha^{-1} yield of tomato while non-AM inoculated with 100% P gave 69.8 t ha^{-1} yield which indicate that inoculation of AM used in nursery bed can save 50% P in the field in 2017. The plant which did not receive AM in nursery bed produced lower yield in all phosphorus levels in the field both in 2016 and 2017.

Effect of Arbuscular Mycorrhizal Inoculation on Mungbean at Different Salinity Levels

Arbuscular mycorrhizal (AM) fungi increase the tolerance of host plants to different level of salinity. A pot experiment was carried out in the nethouse of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur in 2016-17 with the objectives to evaluate the potentiality of arbuscular mycorrhizal inoculation on the germination (%), growth, yield and yield contributing characters of mungbean treated with different salinity levels. The experiment was designed in factorial randomized completely block design with four replications. Five salinity treatments (0, 2, 4, 6 and 8 dS m^{-1}) possessed salinity levels as the first factor and the second factor consists of mycorrhizal and non-mycorrhizal treatments. Soil based mixed arbuscular mycorrhizal (AM) inoculum containing about approximate 275 ± 20 spores and infected root pieces of the host plant was used pot^{-1}. Mycorrhizal plants showed better performance in terms of germination (%), growth parameters, yield and yield parameters than non-mycorrhizal plants. With increasing salinity concentration, germination (%), growth parameters and yield parameters decreased significantly ($p<0.01$). It was observed that 0 dSm^{-1} + AM treatment produced the highest seed yield (7.27 g pot^{-1}) and stover yield (12.97 g pot^{-1}) of mungbean. In contrast, 8 dSm^{-1} treatment produced the lowest seed yield (2.65 g pot^{-1}) and stover yield (8.39 g pot^{-1}) of mungbean. The study clearly indicates that mycorrhizal inoculation could reduce the harmful effects of salinity to the host plants, thus increase plant survival allowing the plants growth under extreme condition.

Effect of Arbuscular Mycorrhizal Fungi and *Rhizobium* on Mungbean in Saline Soil

The present study was carried out to evaluate the effect of indigenous arbuscular mycorrhizal (AM) fungi, *Rhizobium* and three phosphorus levels on mungbean in saline soil in the net house of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2016-17. The experiment was designed in RCBD with 10 treatments and 4 replications. Mungbean variety BARI Mung-6 was used as a test crop. Peat based rhizobial inoculum (BARI RVr-403) was used in this experiment @ 50 g kg^{-1} seed. The population density of used inoculum was more than 10^8 cfu g^{-1} inoculant. The developed soil salinity in each treatment was 4 dSm^{-1}. Soil based AM inoculum containing about approximate 275 ± 20 spores and infected root pieces of the host plant was used pot^{-1}. There were ten treatments viz. T_1: Control, T_2: Arbuscular mycorrhiza (AM) + 50% P, T_3: AM + 75% P, T_4: AM + 100% P, T_5: *Rhizobium* + 50% P, T_6: *Rhizobium* + 75% P, T_7: *Rhizobium* + 100% P, T_8: AM + *Rhizobium* + 50% P, T_9: AM + *Rhizobium* + 75% P and T_{10}: AM + *Rhizobium* + 100% P. Results of the experiment revealed that highest seed yield (6.83 g pot^{-1}, 46.25% higher over control) and stover yield (15.95 g pot^{-1}, 33.03% higher over control) were found in AM + *Rhizobium* + 75% P treatment. The results suggested that inoculation of mungbean with AM fungi or *Rhizobium*, especially double inoculation, causes a considerable increase in mungbean seed yield and stover yield under saline conditions by increasing percent germination, colonization and nodulation.

Integrated Use of Arbuscular Mycorrhiza, Cowdung and Phosphorus in Producing Sweet Gourd Seedling

A pot experiment on the integrated use of arbuscular mycorrhiza, cowdung and phosphorus in producing sweet gourd seedlings was conducted in the Net house of Soil Science Division, BARI, Gazipur during rabi season of 2015-16 and 2016-17. Seven fertilizer treatments viz. T_1: Cowdung (CD), T_2: Arbuscular mycorrhiza (AM), T_3: phosphorus (P), T_4: CD + AM, T_5: P + AM, T_6: CD + P and T_7: CD + AM + P were studied along with T_8: Control for producing seedlings of this crop. Cowdung and TSP were used at the rate of 100 g and 1.0 g pot^{-1}, respectively. Soil based AM inoculum containing about 200 spores and infected root pieces were used in the pot of about 3 cm depth. Dry weight of seedlings, seedling height was found significantly higher with combined application of cowdung, arbuscular mycorrhiza (AM) and phosphorus compared to the remaining treatments.

Effects of *Rhizobium* and Mycorrhizal Inoculation on Nodulation, Plant Characters and Yield of Soybean

Field experiments were conducted at Central Farm of Bangladesh Agricultural Research Institute, Gazipur during 2016-17 with the objectives to determine the effect of various phosphorus levels, nitrogen fertilizer, mycorrhizal incorporation and *Rhizobium* inoculation on nodulation and yield of soybean. Unit plot size was 4 m × 3 m. The experiment was designed in randomized complete block having 3 replications in each treatment. Seven different treatments were T_1: *Rhizobium* inoculant (R) + 100% P; T_2: *R* + Arbuscular mycorrhiza (AM); T_3: *R.* + 75% P + AM; T_4: Nitrogen (N) + 100% P; T_5: N + AM; T_6: N + 75% P + AM and T_7: Control. Among 7 different treatments, *Rhizobium* inoculant with mycorrhizal incorporation and 75% P showed the highest nodule number (75.67 plant^{-1}). The highest plant height (69.16 cm) was observed at the *Rhizobium* inoculant with mycorrhiza and 75% P incorporated plot. Significantly the highest root weight (1.64 g), shoot weight (11.03 g) were also found at the *Rhizobium* inoculant with mycorrhizal and 75% P incorporated plot. The highest root length (15.13 cm) and shoot length (55.50 cm) was found at the *Rhizobium* inoculant with 100% P treated plot. Significantly the highest seed yield (1.78 t ha^{-1}) and stover yield (2.81 t ha^{-1}) were found at the same treatment.

Response of Chickpea Varieties to Elite Strains of *Rhizobium*

Field experiments were conducted at Regional Agricultural Research Station, BARI, Ishurdi during 2015-16 and 2016-17 with the objectives to study the response of inoculation with different varieties and to study the effect of different sites (Agro-ecological zones) with inoculation and varieties. Four varieties/advance lines of chickpea viz. BARI Chola-9, BCX-06001-11, BCX-05001-4, BCX-05008-11 and rhizobial inoculum (*Rhizobium* strain RCa-220) were used in these experiments. Unit plot size was 4 m × 3 m. The experiment was designed in randomized complete block having 3 replications in each treatment. Each variety was tested with/without *Rhizobium* inoculation. Inoculated plants gave significantly higher nodule number, nodule weight, shoot weight, seed yield and stover yield compared to non-inoculated plants. Among 4 varieties/advance lines, BCX-06001-11 advance line produced the highest nodule number both in 2015-16 and 2016-17. The highest nodule weight recorded by BARI Chola-9 and BCX-05001-4 advance line in 2015-16 and 2016-17, respectively. The highest seed yield (2.22 t ha^{-1}) and stover yield (3.13 t ha^{-1}) was recorded at BCX-05008-11 advance line in 2015-16 but in 2016-17 growing season, the highest seed yield (1.84 t ha^{-1}) and stover yield (3.86 t ha^{-1}) were observed at BCX-05001-4 advance line. The interaction effect revealed that the highest seed yield of

2.62 and 1.98t ha^{-1} and stover yield 3.60 and 4.16 t ha^{-1} were recorded by inoculated BCX-05008-11 and BCX-05001-4 advance line of chickpea in 2015-16 and 2016-17 respectively.

Response of Groundnut to the Combined Application of Biochar and Biofertilizer

A field trial was conducted at Regional Agricultural Research Station (RARS), Jamalpur during the period of 2015-16 and 2016-17 with the objectives to increase yield of groundnut using biochar and biofertilizer. The crop variety was BARI Chinabadam-8 and Bradyrhizobium strain was BARI RAh-892. There were seven treatments comprising T_1: (Control), T_2: Soil test based (STB) dose following FRG-2012, T_3: (T_2 - N) + biofertilizer, T_4: T_3 + Biochar, T_5: STB + Biochar, T_6: Only biofertilizer and T_7 Only biochar which were replicated three times. Peat based rhizobial inoculum was used at the rate of 1.5 kg ha^{-1} as seed inoculant. The highest number of nodule (136.7 $plant^{-1}$ in 1st year and 115.5 $plant^{-1}$ in 2nd year), weight of nodule (180 mg $plant^{-1}$ in 1st year and 130 mg $plant^{-1}$ in 2nd year) were obtained from T_4 (T_3 + biochar) treatment. The highest nut yield (2.53 t ha^{-1} in 1st year and 2.36 t ha^{-1} in 2nd year) was obtained from T_4 (T_3 + biochar) treatment. The lowest nut yield (0.83 t ha^{-1} and 0.73 t ha^{-1}) obviously recorded from control (T_1) treatment in both the years. The highest nut yield performed by T_4 treatment might be due to combine the effect of biochar and biofertilizer**.** Rhizobium could be inoculated in biochar amended soil to improve nodulation and growth parameters of groundnut plant.

Effect of Arbuscular Mycorrhizal Fungi and Vermicompost on Growth and Yield of Onion

A field trial was conducted during the rabi seasonof 2016-17 at Regional Agricultural Research Station (RARS), Jamalpur to increase yield of onion using arbuscular mycorrhizal fungi and vermicompost, and to improve P use efficiency as regulated by arbuscular mycorrhizal fungi. There were seven treatments comprising T_1: Control, T_2: Soil test based (STB) dose (FRG-2012), T_3: STB + Arbuscular mycorrhizal fungi (AMF), T_4: (STB – 25% P + AMF), T_5: (Dose of T_2 as supplied 75% from Chemical fertilizers and 25% from Vermicompost), T_6: (T_5 – P + AMF) and T_7: T_5 + AMF. The highest bulb yield (15.28 t ha^{-1}) of onion was obtained from T_7 (T_5 + AMF) treatment which was statistically similar with T_6 (T_5 – P + AMF) treatment and T_4: STB – 25% P + Arbuscular mycorrhizal fungi (AMF) treatment which produced bulb yield of 12.91 tha^{-1} and 11.99 t ha^{-1}, respectively. The lowest bulb yield (4.78 t ha^{-1}) obviously recorded from control T_1 treatment. The highest spore number (97.3) was obtained from T_7 (T_5 + AMF) treatment and the lowest spore number (40.0) was obtained from T_1 treatment. The highest root colonization (34.0%) was found in T_7 (T_5 + AMF) treatment and the lowest colonization (10.7%) was recorded in T_1 treatment. From the trial, it can be concluded that vermicompost and AMF inoculant along with IPNS based chemical fertilizers is the best treatment and it is recommended for onion cultivation.

22 ENTOMOLOGY

Survey of insect pests attacking wheat and determination of their damage potentials

Field surveyes were conducted at the research field of Entomology division, BARI, Gazipur and RARS, Jamalpur during Rabi 2016-17 to record the status of insect pests attacking wheat and their natural enemies. Several insect pests viz. aphid, shoot fly and stem borer were found to attack wheat crop at different growth stages at Gazipur, but brown beetle and leaf beetle were found to attack wheat crop at Jamalpur while lady bird beetle and spider were recorded as natural enemies in both locations.

Survey of insect pests attacking maize and determination of their damage potentials

A survey was carried out in six maize growing fields of RARS, Jamalpur and in the farmers' field during Rabi 2016-17 to document the damage severity of insect pests of maize and their natural enemy. Several insects pests viz. aphid, whitefly, jassid and stem borer were found in maize fields of RARS, Jamalpur at different growth stages. Whitefly and jassid showed highest infestation in March. A number of natural predators were found during the study period.

Development of bio-rational based management approaches against corn ear worm, *Helicoverpa zea* attacking maize

The experiment was conducted at Entomology division, BARI, Gazipur, during Rabi 2016-17 to evaluate different biorational based management approaches against corn earworm infesting maize. The result revealed that the lowest plants damage (1.22%) was attained in treatment of pheromone + spraying of spinosad (Succes 2.5 SC) @ 1.2ml/L of water treated plots and highest plant damage reduction over control (58.36%) was also attained in the same treatment. The highest plant damage (2.86%) was found in untreated control plots. The infested cob ranged from 0.69 to 1.38% and did not differed significantly among the reatments because *H. zea* population was minimal during the reproductive stages. So there was no significant difference among the treatments effects on yield of maize.

Evaluation of different managment packages against flower thrips and pod borers of mungbean both in farmer's field and on station conditions

Experiments were conducted to evaluate the different management packages against flower thrips & pod borer complex of mungbean at entomology research field of BARI, Gazipur and at RARS, Rahmatpur during Kharif-I, 2017. Thrips population were significantly reduced after two spraying with Intrepid 10EC @ 1ml/L of water at flower initiation stage and peak flowering and podding stage. Pod infestation was also lower (3.41%) in IPM package 2 (Planting site sanitation + installing white sticky trap + two sprays of Chlorfenapyr (Intrepid 10 SC) @ 1ml/L of water first at flower initiation stage and second at after 7 days interval at peak flowering and podding stage + third spraying with Emamectin Benzoate (Proclaim 5 SG) @ 1g/L of water at seed developing stage at 7 days after second spray) resulted the highest yield (1.15 t/ha), followed by IPM package 1 (Planting site sanitation + installing white sticky trap + two sprays of azadirachtin (Bio-neem plus1EC) @ 1ml/L of water first at flower initiation stage and second at after 7 days interval at peak flowering and podding stage + third spraying with spinosad (Success 2.5 SC @ 1.25 ml/L of water at seed developing stage at 7 days after second spray plots) at Gazipur while 2.98% pod infestation with 1180 kg/ha yield and the highest MBCR (1.30) was obtained from same package (Package2) at RARS, Rahmatpur.

Evaluation of some management packages against pod borer, *Helicoverpa armigera* infesting chickpea in farmer's field and on station conditions

The experiment was conducted at research field of Entomology division, BARI, Gazipur, during rabi 2016-17 to evaluate different IPM packages against pod borer, *Helicoverpa armigera* attacking chickpea. BARI Chola-9 were used along with the IPM packages. Results indicated that the lowest percent pod damage (3.90%) and highest yield (1.47 t/ha) was recorded from IPM package 2 (Sex pheromone mass trapping + Spinosad (Success 2.5SC @ 1.2 ml/L of water) followed by IPM package 1 (Sex pheromone trapping + Spraying of *Helicoverpa* nuclear polyhedrosis virus (HNPV) @ 0.1g/L of water).

Comparative evaluation of different IPM packages against major insect pests of brinjal

A field experiment was conducted at Bangladesh Agricultural Research Institute (BARI), Gazipur and RARS. Jessore during the Rabi season of 2016-17 for evaluating different bio-rational based management approaches against major insect pest of brinjal. The results indicated that, at Gazipur IPM package 2 (Mechanical control + Diafenthuron (Pegasus 500SC @ 1ml/L of water) + Sex pheromone trapping + Spinosad (Success 2.5 SC) @ 1.2ml/L of water) was the most effective against major insect pest of brinjal. Significantly lowest pest populations were observed in all the IPM packages than the farmers' practice plots. The lowest fruit infestations was found in the IPM package 2 (8.25%) and the highest percent reduction (75.95%) of fruit infestation over control. The highest yield was recorded in the IPM package 2 (20.99 t/ha) treated plot followed by IPM package 3 (19.11 t/ha). The highest net return (284190/- Tk/ha) and Marginal Benefit Cost Ratio (MBCR) (4.06) was obtained from IPM package 2 treated plot. Same trends of results were recorded at RARS, Jessore.

Bio-rational management of red spider mite on brinjal

A field experiment was conducted at Regional Agricultural Research Station, Burirhat, Rangpur during the Rabi season of 2016-17 with a view to find out the management approaches against red spider mite on brinjal. There were seven treatments viz. T_1= application of neem seed extract @ 50g/L of water, T_2= Azadirachtin (Bio-neem plus 1EC) @1ml/L of water, T_3= Abamectin (Vertimec 1.8EC) @ 1.2 ml/L of water, T_4= alternate use of abamectin and neem seed extract, T_5= Alternate use of abamectin and azadirachtin, T_6= propargite (Omite 57 EC) @ 1.5 ml/L of water, and T_7 = Untreated control. Results revealed that alternate spraying of abamectin with neem seed extract (T_4) and alternate spraying of abamectin with azadirachtin (T_5) controlled red mite effectively. These two treatments reduced red mite 81 to 94% over the untreated control.

Development of bio-rational management packages against major insect pests of tomato

A field experiment was conducted at the experimental field of Entomology Division, BARI Gazipur during 2016-17 to develop a bio-rational based IPM package against major insect pests of tomato. Results indicated that IPM Package 1 comprising of pheromone mass trapping + resistant variety (BARI Tomato-15) offered the lowest virus infected plants (0.83%) and fruit infestation by borer was (0.28%) in IPM Package 1 treated plot. However, the highest marginal benefit cost ratio MBCR (10.16) was also obtained from management package 1.

The status of tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) monitoring through pheromone trap

The study was conducted in the experimental field of Entomology Division, BARI, Gazipur, RARS, Jessore, RARS, Barisal and RARS, Burirgat, Rangpur during 2016- 2017 to know the status of tomato Leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) on continuously grown of tomato. The incidence of this pest was monitored through pheromone trap. Two types of lure (UK and Indian) were used for monitoring this pest. The incidence of this pest is comparatively high in the month of March -April and then declined. It was observed that the efficacy of UK lure is better than the Indian lure. *Tuta absoluta* were captured in trap at BARI Gazipur highest (13/trap/ week) in UK lure trap in 2^{nd} week of April. But at Jamalpur, it was observed in mid Janualy and continued up to February. The highest no. of *Tuta absoluta* captured in UK trap was 6.0/trap/week in mid February. No adults were catched through Indian product at Jamalpur. In 24 January 2017, *T. absoluta* moth was captured first time at RARS, Burirhat, Rangpur. It was observed that UK made pheromone lure attracted *T. absoluta* effectively where no or few *T. absoluta* moth attracted by India made pheromone lure (Figure 1). The highest mean number (39) of *T. absoluta* was captured during first week of April 2017 in UK pheromone lure at Burirhat, Rangpur. No *Tuta absulata* was observed at RARS, Barisal and Jessore during 2016-17 season by sex pehromone trap monitoring.

Development of integrated pest management against tomato leaf miner (*Tuta absoluta*)

A field experiment was carried out at RARS, Burirhat, Rangpur during the Rabi season of 2016-17 with a view to find out the management options against *T. absoluta* on tomato plants. There were six treatments viz. T_1= pheromone mass trapping, T_2= T_1 + spraying of azadirachtin (Bio-neem plus 1EC) @1.0 ml/L of water, T_3= T_1 + spraying of *Bacillus thuringiensis* (Kursaki) @ 1.0 g/L of water, T_4= T_1 + spraying of spinosad (Success 2.5 SC) @ 1.2 ml/L of water, T_5= spraying of imidacloprid (admire 200 SL) @ 0.5 ml/L of water, and T_6= untreated control. Results showed that pheromone mass trapping with spraying of either spinosad (11.26 ± 1.3%) or azadirachtin (14.66 ± 1.5%) or *B. thuringiensis* (14.25 ± 1.2%) controlled tomato leaf miner, *T. absoluta* effectively.

Efficacy of repellents against different insect pests and natural enemies of tomato

The experiment was conducted during Rabi season 2016-17 at Entomology division, BARI, Gazipur and Regional Agricultural Research Station, Jessore. The repellency of 2 chemicals were evaluated against major insect pests of tomato and brinjal. The treatments were as follows: T_1 = Ketone, T_2 = Methyl Salicylate, T_3 = Untreated control. The results showed that no significant differences in repellency of ketone and methyl salicylate were observed on sucking pest of tomato at Gazipur. But in case of brinjal aphid and jassid were significantly educed in ketone and methyl salicylate treated plot compared to control. While no significant difference was observed at Jessore in controlling sucking and borer pest of tomato.

Study on the management of leaf miner in ridge gourd

An experiment was conducted at RARS, Jamalpur to find out the appropriate management approach for controlling leaf miner in ridge gourd. Leaf miner infestation started at 15 days of plant age i.e., 3 leaf stage and it was maximum in the bottom part of the plant in ridge gourd. Results revealed that the lowest leaf infestation (4.33%) and highest yield (16.47 t/ha) was recorded from the plots treated with plastic mulch + Spinosad (Success 2.5 SC) @ 1.2ml/L of water + netting at seedling stage which was statistically similar with sanitation with azadirachtin (Bioneem plus 1EC) @1ml/L of water + netting at seedling stage). The result also revealed that the highest MBCR was observed in the plots treated with plastic mulch with Spinosad treated plots (5.30) followed by sanitation with Bioneem treated plots (5.29).

Up scaling and field validation of bio-rational based integrated management package against fruit fly of sweet gourd

The experiment was conducted during Rabi season 2016-17 at Regional Agricultural Research Station, Jessore. The treatments were as follows: T_1 = IPM package 1: Sanitation+ Sex pheromone traps for fruit files, T_2 = IPM package 2: Sanitation + Sex pheromone traps for fruit flies and 3 times application of spinosad (Tracer 45 SC) @ 0.4 ml/L of water, T_3 = Farmers practice: Application of synthetic chemical insecticide (Voliam Flexi 300 SC) @ 0.5 ml/L of water. The lowest fruit infestation (10.67%) as well as the highest yield (31.46t/ha) was obtained from IPM package 2 and also found 33.34% yield increased over control. The highest marginal benefit cost ratio (MBCR) (3.04) was obtained from IPM package 2.

Comparison of insect pest populations between floating bed and conventional practices in cucumber

The present study was carried out in the cucumber plots at Barisal region of Bangladesh during winter and early summer 2016-17 to compare the insect pests of cucumber between floating bed and plain land. A number of insect pests were recorded in both floating bed and plain land. Different insect pests namely red pumpkin beetle, leaf miner, whitefly, fruit fly, pumpkin caterpillar, common cutworm and aphid were recorded during the study period. Cucumber grown on floating bed has less insect infestation compare to grown on plain land. Cucumber grown in winter season has less insect infestation compare to grown in early summer. Pumpkin caterpillar and leaf miner recorded only in early summer grown cucumber in both floating bed and plain land.

Development of bio-rational management against major insect pests attacking country bean

A field experiment was undertaken at research field of Bangladesh Agricultural Research Institute (BARI), Gazipur during rabi 2016-17 cropping season to evaluate several treatment against major insect pests attacking country bean. Results indicated that, thrips population decreased significantly during 1-3 days after spraying. The aphid population observed very low in all treated plots. Pod infestation was less than one percent in all treatments. It was revealed that percent inflorescence infestation (7.43 %) by borer were significantly lowest in the chlorfenapyr (Intrepid 10EC)@ 1ml/L+ alternate spray of MNPV@ 1g/l and spinosad (Success 2.5SC) treated plot and this was followed by azadirachtin (Bioneem plus 1 EC) @1ml/L+ alternate spray of MNPV@ 1g/L and spinosad (Success 2.5 SC) where inflorescence infestation by borer was 7.43 %, and 10.61 %, respectively. The highest yield (13.33 t/ha) was obtained from the plot treated with chlorfenapyr (Intrepid 10EC)@ 1ml/L+ alternate spray of MNPV@ 1g/L and spinosad (Success 2.5SC) followed by the plot treated with azadirachtin (Bioneem plus 1 EC) @1ml/l+ alternate spray of MNPV@ 1g/L and spinosad (Success 2.5 SC) @ 0.5ml/L and Imidacloprid (Imitaf 20SL) @ 1ml/L+alternate spray of MNPV@ 1g/L and spinosad (Success 2.5 SC).

Development of bio-rational based integrated management packages for the major insect pests of cabbage

The study was conducted in the experimental field of Entomology Division, BARI, Gazipur during 2016-17 to develop an IPM package for insect pests of cabbage grown under different planting dates. Three IPM packages along with farmers practice were evaluated in this study. The five treatments were: T_1= IPM package 1: Hand picking + Pheromone trapping for *S. litura* + spraying Bt (EG 7841) @ 2g/3L of water at 10 days interval); T_2= IPM package 2: Pheromone trapping for *S. litura* + spraying Bt (EG 7841) @ 2g/3L of water at 10 days interval); T_3= IPM package 3: Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3L of water at 10 days interval) + SNPV @ 0.2g/L of water of water at 10 days interval ; T_4= Farmers practices : Spraying of cypermethrin 10 EC @ 1ml/L of water at 7 days interval; T_5= untreated Control. Results indicatd that cabbage planted in September 2016 showed infestation of leaf-eating caterpillars, where head infestation was 2.11-2.48% in IPM plots. Very low infestation was observed in the October 2016 transplanting, which was harvested till February 2017. The head infestation was 1.38-3.08% in the IPM treated plots while, it was 7.74% in control plot. Significantly higher yields were also recorded in the IPM treated plots than the untreated control plots. Healthy cabbage yield was also significantly higher in the IPM plots than the farmers' practice plots & untreated plots.

Development of bio-rational based integrated management package(s) for the major insect pests of cauliflower

The study was conducted in the experimental field of Entomology Division, BARI, Gazipur during 2016-2017 to develop IPM package(s) for major insect pests of cauliflower. There were five treatments and three replications and the experiment was set following RCB design. Five treatments were, T_1= IPM package 1: Hand picking + Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3L of water at 10 days interval; T_2= IPM package 2: Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3L of water at 10 days interval; T_3= IPM package 3: Pheromone trapping for *S. litura* + Bt (EG 7841) @ 2g/3L +SNPV @0.2g/L of water of water at 10 days interval; T_4= Farmers' practice: Spraying of cypermethrin 10EC @ 1ml/L of water at 7 days interval; T_5= Untreated control. Results indicated that the lowest (0.48 %) curd infestation was observed in October transplanting in IPM package 2. IPM package3 provided higher yield (20.67t/ha and it was statistically similar to IPM packages1 and IPM packages2

Loss assessment of potato due to infestation of root aphid (*Pemphigus* sp.) at different potato growing areas of Joypurhat

A field survey was conducted at different locations of Joypurhat districts during 2016-17 to determine the intensity of infestation of potato root aphid. According to farmers' perception, yield loss by the pest was 10-35%. Farmers sprayed different insecticides 3 to 4 times to combat the pest. Farmers called the pest in the name of 'Karent poka'. This is a new pest in Bangladesh, its management strategies need to be developed.

Management of common cutworm (*Spodoptera litura*) on aroid at farmers' field condition

An experiment was conducted at the MLT site, Joypurhat during 2016-17 to observe the performance of integrated management practice against common cut worm in aroid under farmer's field condition. There were two treatments viz. T_1: IPM Approach (Pheromone trap + Collection and destruction of egg masses & larvae+ application of SNPV @ 0.2 g/L of water) and T_2:Farmers practice (with insecticide- chlorpyriphos (Morter 48 EC) @ 2ml/L of water, 10 times spray at 7 days interval). Result indicated that the lowest no of larvae/leaf (2.53/10 leaf), percent of infested leaf (7.13%), percent of infested stolon by no (2.41%) highest yield of stolon (21.37 tha^{-1}) & rhizome (21.19 tha^{-1}) was obtained from the treatment T_1 compared to farmers practice. Higher gross return (Tk. 579283/ha) and gross margin (Tk 574278/ha) was also recorded from the treatment.

Development of bio-rational based management approach against mango hoppers, *Idioscopus* spp.

Field experiment was carried out following randomized complete block design with 4 treatments and 3 replications during the mango season of 2017 at fruit farm, HRC, BARI, Gazipur as well as Regional Horticulture Research Station, Chapainawabganj to find out an effective bio-rational based management option for the control of mango hopper. The treatments were assigned as T_1= two sprays of microbial pesticide (*Beauveria bassiana*) @ 5.0g/L of water-first spray within 10 days of flowering and second at pea stage of fruit growth, T_2 = spraying of *B. bassiana* @ 5.0g/L of water within 10 days of flowering and spraying of Bio-neem plus 1 EC @ 1.0ml/L of water + mancozeb (Indofil M-45 @ 2.0g/L of water at pea stage of fruit growth, T_3 = two sprays of azadirachtin (Bio-neem plus 1 EC) @ 1.0ml/L of water + Indofil M-45 @ 2.0g/L of water-first spray within 10 days of flowering and second at pea stage of fruit growth and T_4= untreated control with water spray only. Results indicated that treatment T_2 was found the most effective for the control of both nymph and adult population of mango hopper and gave the highest MBCR (0.740) and fruit retention (188.8%) at mature stage over untreated control at Gazipur. At Chapainawabganj treatment was also found the most effective option for the control of both nymph and adult populations of mango leaf hopper and gave the higher fruit retention at both pea and marble stages (80.9 and 85.3%, respectively). Two sprays of B. bassiana @ 5.0 g/litre of water offered satisfactory reduction of both nymph and adult populations of mango leaf hopper and provided 73.55% fruit retention at pea stage and 60.94% at marble stage.

Development of management approach against mango fruit fly, *Bactrocera dorsalis*

A field experiment was carried out during the mango fruiting season of 2017 at Lac Research Station, Chapainawabgonj to find out an effective management option for the control of mango fruit fly, *Bactrocera dorsalis* (Hendel) (Tephritidae: Diptera). Both of brown paper bag and polybag gave full protection against fruit fly infestation while methyl euginol and control treatments showed 5.32% and 11.83% fruit infestation, respectively. However methyl euginol reduced more than 50% infestation over untreated control. Polybag controlled fruit fly infestation but enhanced fruit damaged/black spotted (32%) fruits while brown paper bag, methyl euginol and control treatments produced 5.3%, 7.44% and 8.6% damaged/black spotted fruits, respectively. Bagging of fruits reduced percent total soluble solids with the lowest (21.4%) in polybag bagging. The highest TSS (23.8%) was recorded in methyl euginol treatment followed by control treatment (23.7%). Brown paper bagging reduced damage/black spots on fruits as compared to other treatments.

Field validation of ICM technologies in reducing flower and fruit dropping of mango at different regions of Bangladesh

A field experiment was carried out during the mango fruiting season of 2017 at Sadar and Shibgonj, Chapainawabgonj; Mithapukur, Rangpur; Chaugasa, Jessore; Tala, Satkhira and fruit farm, BARI, Gazipur to validate ICM technologies in reducing flower and fruit dropping of mango at different regions of bangladesh Sadar and Shibgonj, Chapainawabgonj; Mithapukur, Rangpur; Chaugasa, Jessore; Tala, Satkhira and fruit farm, BARI, Gazipur. ICM packages were:

1) Recommended fertilizer doses: application of half-urea, half-MOP and all other fertilizers during mid-September to end of September remaining urea and MOP application in two equal splits-first at pea stages of fruit growth during end of March and 2nd at mature stage during May. 2) Two sprays with imidacloprid (Confidor) 70WG @ 0.2g/litre of water or cypermethrin (Ripcord 10EC) @ 1.0ml/L of water and mancozeb (Indofil M-45) @ 2.0g/L of water : first application within 7-10 days of flowering (before opening of the flower) and 2nd application at pea stage of fruit growth, generally after 4-5 weeks of the first spray application. 3) Two sprays with 2% urea solution at pea and marble stage of fruit growth. 4) Four irrigations starting from full bloom to fruit maturity at 15 days interval and 5) Non-ICM: Farmers practices. Results indicated that recommended fertilizer and two sprays with imidacloprid (Confidor) 70WG @ 0.2g/L of water or cypermethrin (Ripcord) 10EC @ 1.0ml/L of water and mancozeb (Indofil M-45) @ 2.0g/L of water: first application within 7-10 days of flowering and 2nd application at pea stage of fruit growth, two sprays with 2% urea solution at pea and marble stage of fruit growth and four irrigations starting from full bloom to fruit maturity at 15 days interval increased (90.47%) number of mature fruits over non-ICM. However, weight of fruit increased 10.93% over non-ICM.

Development of management approach against mango nut weevil, *Sternochetus mangiferae*

Study was carried out at mango orchard of BARI Aam-4 at RARS, Burirhat, Rangpur during April-July 2017 to develop a suitable management approach against mango nut weevil. Five treatments have been selected for this study viz. T_1 = Cultural practices, a) Sanitation + Collection and destruction of fallen fruits and seeds after harvest b) Raking of soil below tree during fruiting season, $T_2 = T_1$ + lambda cyhalothrin (Karate 2.5 EC) @ 1ml/ L of water, $T_3 = T_1$ + spinosad (Success 2.5EC) @ 1.2 ml/ L of water, $T_4 = T_1$ + thiamethoxam (Actara 25 WG) @ 0.2g / L of water T_5 = Untreated control. Spraying was started at marble sized of mango and three consecutive sprays were applied at 10 days interval. Results showed that cultural practice with application of thiamethoxam suppressed mango nut weevil abstemiously.

Efficacy of different control measures against litchi mite (*Aceria litchi* keifer)

The experiment was conducted at Fruit research station, Binodpur, Rajshahi duuring 2016-17 to know Litchi mite (*Aceria litchi*), its extent of damage to litchi leaves and inflorescence and the effectiveness of different management practice for controlling litchi mite. There were five treatments viz. T_1 = Two pruning of infested foliage 1st on June after harvesting fruits and 2nd on August + Spraying of abamectin 1.8 EC (Vertimec 1.8 EC @ 1.5 ml /Lof water in February before opening flower) T_2 = Two pruning of infested foliage 1st on June after harvesting fruits and 2nd on August + Spraying of wettable Sulphur (Thiovit 80 WP @ 2 g/L of water in February before opening flower) T_3 = Two pruning of infested foliage 1st on June after harvesting fruits and 2nd on August + Spraying of dimethoate 40 EC (Tafgor 40 EC @ 2 ml/L of water in February before opening flower) T_4 = Two pruning of infested foliage 1st on june after harvesting fruits and 2nd on August, T_5 =Untreated control. Results indicated that the lowest leaf infestation (3.65 %) as well as the lowest inflorescens infestation (2.25%) was observed from the treatment pruning of infested foliage + one spray of abamectin 1.8 EC (Vertimec 1.8 EC) @ 1.5ml /L of water with 89.11% leaf infestation reduction over control which is statistically different from other treatments while, the highest leaf infestation (33.53 %) was observed from untreated control. The highest MBCR was found in treatment T_2 (5.20) and lowest in T_4 (3.67).

Development of bio-rational based management approaches for the control of litchi fruit borer, *Conopomorpha sinensis* Bradley

The study was conducted at the litchi orchard of Regional Agricultural Research Station, Ishurdi, Pabna as well as RARS, Burirhat, Rangpur during 2017 to find out the best bio-rational management practices for the control of litchi fruit borer. Six treatments were as follows;T_1 = Natting of fruits with mosquito net (64 mesh) started from marble stage; T_2 = Spraying of azadirachtin (Bioneem plus 1EC) 2 times started from at early ripening stage @ 1 ml/L of water at 10 days interval commencing from the first incidence. T_3 = Spraying of spinosad (Success 2.5EC) 2 times started from at early ripening stage @ 1 ml/L of water at 10 days interval.T_4 = Spraying of imidachlopride (Admire 20SL) 1 time started from at early ripening stage @ 0.5 ml/L of water at 14 days interval.T_5 = Spraying of cypermethrin (Repcord 10EC) 2 times started from at early ripening stage @ 1 ml/L of water at 10 days interval.T_6 = Untreated control. Results indicated that among six treatments netting of fruits with mosquito net (64 mesh) showed the lowest infestation (3.3%) significantly followed by spraying of Imidachloprid (Admire 200SL) @ 0.5ml/ L of water (50%). While, the higest infestation was observed in untreated control (92.2%) at Burirhat. At RARS, Ishurdi the lowest infestation was observed in treatment T_4 while, the highest number (29.33%) of infested fruit was recorded from untreated control.

Study on the pest status of different insects and mite pests and their natural enemies on citrus at Gazipur

A field survey was conducted at the citrus research orchard BARI, Gazipur during November 2016 to May 2017 to document the major insect pests of citrus and their natural enemies. Seven different types of insects mite pest namely leaf miner, asian citrus psyllid, mealybug, flower thrips, fuller rose beetle, citrus scale, and mite were recorded during the study period. Among them flower thrips and citrus fruit mite infestation was found very high up to 40.14% and 33.33% infestation respectively. The highest no. of natural enemy population was observed in BARI Lebu 3 (7.47/plant) which was statistically identical to BARI Lebu 2 (7.41).

Development of management tactics against flower thrips (*Megalurothrips* sp.) in citrus

A study was conducted in the citrus orchard at Entomology research field2, BARI, Gazipur to develop a suitable management approach for controlling citrus flower thrips. There were five treatments viz. T_1= Spinosad (Success 2.5SC) @ 1.2ml/L, T_2= Alternate spraying of spinosad + azadirachtin (Bio-neem plus 1EC) @ 1.0ml/L, T_3= Alternate spraying of chlorfenapyr (Intrepid 10EC) + azadirachtin, T_4= Chlorfenapyr@ 1.0ml/L and T_5 = Untreated control. Results revealed that the lowest number (10.67) of flower thrips/flower was recorded from treatment T_3 comprising alternate spraying of chlorfenapyr (Intrepid 10EC) + azadirachtin @ 1.0 ml/L which was statically identical with T_4, T2 and $T_{1.}$ The highest number of flower thrips (51.83%) reduction over control was observed in treatment T_3 followed by T_4 (44.56%) and T_2 (40.68%) respectively.

Occurrence, distribution and monitoring of papaya mealybug, *Paracoccus marginatus* and the parasitoid *Acerophagus papayae* on different vegetables and fruits crops especially in the Indo-bangla border

A field survey was conducted at different region of Bangladesh during February-May, 2017 to estimate the damage severity and occurrence of papaya mealybug, *Paracoccus marginatus*, as well as the status of parasitoid *Acerophagus papaya.* Damage severity was estimated by 0-9 scale. Population of papaya mealybug was found in all the surveyed areas. The occurrence of papaya mealybug ranges between 0.11-2.33 score, mean that approximately 3.0-35.0% infestation on leaves/fruits of papaya. The highest leaves infestation (2.33 score) was estimated in the district of Joypurhat & Gazipur. The lowest was observed in Jaintapur, Sylhet. The parasitoid *Acerophagus papaya* was observed in samples collected from Jessore, Rajshahi, Joypurhat, Jointapur and Gazipur locations.

Survey and documentation of different insect pollinators/visitors in different fruit crops during flowering period

The field experiments were conducted at Fruit Research Station, BARI, Binodpur, Rajshahi during 2016-17 on different fruit crops viz Wax jambu, Wood apple, Longan, Pummelo, Phalsa and Ber. Population abundance was recorded by selecting 50 cm length from the tip of the branches for five minutes of fruit trees at two times, 8 am and 11 am for three days. It was observed that the highest number (4.67) of visitor found in wax jambu was Honey bee followed by Flower fly (3.00) and Syrphid fly (1.00). In wood apple the insect population was the highest (4.16) of Honey bee followed by Flower fly (2.00) and Syrphid fly (1.83). In longan the insect population was the highest (4.33) of Blow fly followed by Flower fly (4.00), Honey bee (3.00), House fly (2.33) and Syrphid fly (0.83). In pummelo (Citrus) the insect population was the highest 2.17 of Bumble bee followed by Honey bee (0.83) and Syrphid fly (0.50). In phalsa the insect population was the highest 1.33 of unknown insect followed by Flower fly (1.17), Honey bee (0.50), and Bumble bee (0.17). In Ber the insect population was the highest 3.00 of Wasp followed by Honey bee (1.67), Flower fly (0.67), Blow fly (0.50) and House fly (0.33).

Development of management approach against thrips-mite complex in chilli

An experiment was carried out during 2016-2017 in the Entomology research field of BARI, Gazipur to find out the best management approach to combat thrips-mite complex of chilli. Six treatments were assigned as follows: T_1= White sticky trap @ 40 trap/ha; T_2= Spraying of chlorphenapyr (Intrepid 10SC) @ 1ml/L of water; T_3= White sticky trap + chlorphenapyr (Intrepid 10SC) @ 1ml/L of water; T_4= White sticky trap + abamectin (Vertimec 1.8EC) @ 1.2 ml/L of water + spinosad (Success 2.5SC) @ 1.2 ml/L of water; T_5= White sticky trap + abamectin (Vertimec 1.8EC) @1.2 ml/L of water +

azadirachtin (Bioneem plus 1EC) @ 1ml/L of water; T_6= Untreated control.The management approach T_5 appeared as the best management option against thrips-mites complex recording the lowest thrips population (0.67/twigs, 1.34/twigs and 1.22/twigs at 24 hour, 48 hour and 72 hour after spray respectively) and the lowest mites population (0.33/leaf). The highest yield (16.74 t/ha) was also found in T_5 treated plots while, the highest marginal benefit cost ratio (MBCR) (13.60) was achieved from chlorphenapyr (Intrepid 10SC) @ 1ml/L of water which was followed by white sticky trap + abamectin (Vertimec 1.8EC) @1.2 ml/L of water + azadirachtin (Bioneem plus 1EC) @ 1ml/L of water (13.50) treated plots.

Survey, monitoring, and documentation of major insect pests of betel leaf in southern region of Bangladesh

The present study was carried out in the betel leaf garden at Barisal region of Bangladesh during 2017 to monitor the insect pests of betel leaf. A number of insect pests were recorded during the study period. Different insect pests namely betel vine black fly, white fly, mealy bug, snail, common cutworm, thrips and red spider mite were recorded during the study period. Among them betel vine black fly, white fly, mealy bug, and snail were found to more damaging one causing 66.7, 32.2, 22.5 % damage, respectively. It is also found that farmers were applied different insecticides (16 insecticides under 10 groups) indiscriminately to control those pest.

Seasonal incidence and effect of abiotic factors on population dynamics of major insect pests on some selected vegetables and fruits

Studies were carried out at Gazipur, Jamalpur, Jessore, Rangpur, Rajshahi and Chapainawabgonj during May 2016 to April 2017 under natural field condition in order to understand the seasonal occurrence and activity of insect pest on some selected vegetables and fruits. Monitoring was done by using sex pheromone traps of eight important pests, viz. common cutworm (*Spodoptera litura*), fruit worm (*Helicoverpa armigera*), DBM (*Plutella xylostella*), sweet potato weevil (*Cylas formicarius*), Mango fruit fly (*Bactrocera dorsalis*), BSFB (*Leucinodes orbonalis*), cutworm (*Agrotis ipsilon*) and cucurbit fruit fly (*Bactrocera cucurbitae*). Temperature, humidity & rainfall data was recorded during the experimental period. There was a profound effect of environment (temperature, humidity & rainfall) on population fluctuation of the specific insect pests and that was positively correlated.

Development of an integrated pest management package for the control rice weevil (*Sitophilus oryzae*) infesting stored maize

This study was carried out in the laboratory of Entomology division, BARI, Gazipur during 2016-2017. Results indicated that among the treatments, package1 consisting gunny bag treated with Sevin 85 WP @ 10.0g/litre of water + dried neem seed powder @ 50.0g/Kg + naphthalene ball @ 4.0/Kg seed provided the lowest infestation of rice weevil by number (2.37%) and weight (2.67%) followed package 3 consisting gunny bag will be treated with sevin 85 WP @ 10.0g/litre of water + seed mixed with castor oil at 10.0ml/Kg seed + neem seed powder @ 50.0g/Kg both in number (3.39%) and weight (2.75%), respectively.

Development of integrated pest management package for pulse beetle, *Callosobruchus chinensis* (l.) Infesting stored mung bean

This study was carried out in the laboratory of Entomology division, BARI, Gazipur during 2016-2017. Results indicated that all packages reduced pulse beetle significantly. Package 3 consisting gunny bag treated with Sevin 85 WP @ 10.0g/litre of water + seed mixed with castor oil at 10.0ml/Kg seed + neem seed powder @ 50.0g/Kg provided the lowest infestation by number (1.06%) and weight (1.06%) followed by Package2 comprises with dried lantana leaves cover as top and bottom surface of seed lot + alluminium phosphide 57% (Phostoxin) @ 4 tablets/ton seed, while, the highest infestation was observed in untreated control treatment (46.45%)

Assessment of the pest status and seasonal fluctuation of major insect pests of stored wheat, maize and mungbean

This study was carried out in the laboratory of Entomology Division, BARI as well as farmers' house at Gazipur during January to June 2017 to document the infestation status and seasonal fluctuation of insect pests of stored wheat, maize and mungbean. It was observed that stored wheat and maize grain was infested by rice weevil, rice meal moth and red flour beetle on the other hand mungbean seed was infested by only pulse beetle. Stored wheat and maize seed infestation was started at mid-February and reached in 26.20% and 18.93%, respectively at the mid-June. Adult rice weevil was first appeared at mid-February whereas, rice moth and red flower beetle were first appeared at the end of March in wheat and maize. Mung bean infestation was started at mid-March and gradually increased and reached at 7.87% in mid-June. Adult pulse beetle was first appeared at the mid-March.

Evaluation of bio-pesticides and botanicals for the management of lac predators and their safety to lac insect

An experiment was carried out at 20 years old ber orchard of Lac Research Station, Chapainawabganj during July to October 2016 Kartiki lac crop season to evaluate several bio-pesticides and botanicals against lac predators. Results indicated that, spraying of Neem seed extract @ 10g crushed seed/litre of water was found the most effective in reducing *Eublemma amabilis* (77.50% reduction) and *Pseudohypatopa pulverea* (75.65% reduction) population over untreated control identically followed by spraying of azadirachtin (Bio-neem plus 1EC) @ 1.0 ml/L of water reducing 72.50% *E. amabilis* and 72.54% *P. pulverea*. The highest lac yield (6.78 kg/plant) was obtained from Neem seed extract @ 10g crushed seed/litre of water treated plants followed by azadirachtin 1EC @ 1.0 ml/litre of water treated plants (6.10 kg/plant) and spinosad (Success 2.5 SC) @ 1.2 ml/L of water (5.47 kg/plant). The highest MBCR (8.81) was obtained from Neem seed extract @ 10g crushed seed/L of water treated plants followed by azadirachtin 1EC @ 1.0 ml/L of water treated plants (4.26) and spinosad (Success 2.5 SC) @ 1.2 ml/Lof water (1.56).

Farmers' participatory trial on the predator management of lac insect in Baishakhi crop season

An experiment was carried out on 8 years old ber trees in farmer's field at Nachole area of Chapainawabganj during February–April, 2017 baishakhi lac crop season to evaluate one bio-pesticide and one botanical against lac predators. Results indicated that, spraying of neem seed extract @ 10g crushed seed/litre of water was found the most effective in reducing *Eublemma amabilis* (61.78–84.55% reduction) and *Pseudohypatopa pulverea* (62.50–72.34% reduction) population over untreated control, followed by spraying of Azadirachtin (Bio-neem plus 1EC) @ 1.0 ml/L of water reducing 58.12–76.42% *E. amabilis* and 54.02–73.68% *P. pulverea*. The highest lac yield (3.95 kg/plant) was obtained from neem seed extract @ 10g crushed seed/litre of water treated plants followed by azadirachtin 1EC @ 1.0 ml/L of water treated plants (3.73kg/plant). The highest mortality of lac insect and the lowest yield of lac were found in untreated control plants.

Efficacy of fungicides for the control of sooty mold on lac crops in kartiki season

An experiment was carried out at Lac Research Station, Chapainawabganj during July to October 2016 Kartiki lac crop season to evaluate fungicides for the control of sooty mold on lac crops in kartiki season. Results indicated that the lowest mortality (74.31%) was found by using Tilt @ 0.5ml/L of water treated plants, while the highest mortality (82.06%) of lac insect was observed in control treatment. The highest yield (6.35 kg/plant) was found in Tilt @ 0.5ml/L of water treated plants followed by Tilt @ 0.25ml/L of water treated plants (6.06 kg/plant), Mancozeb (Indofil M 45) @ 2.0 g/L (5.94 kg/plant) and Mancozeb (Indofil M 45) @ 1.0 g/litre of water treated plants (5.89 kg/plant), while the highest mortality (82.06%) of lac insect was observed in control treatment. There is no significant difference in yield of lac from the plants treated with different materials.

Study on the harvesting time of baishakhi lac crop for maximizing lac yield

An experiment was conducted at the experimental field of Lac Research Station, Kallyanpur, Chapainawabgonj during November 2016 to June 2017 baishakhi lac crop season with six different harvesting time of the crop following randomized complete block and replicated design to the proper harvesting time of baishakhi lac crop for maximizing lac yield. The yield of fresh sticklac, dried sticklac and seedlac obtained in different harvesting time varied significantly. Results indicated that the highest yield of fresh sticklac (5.61 kg/tree) was obtained when harvested at mid-May identically followed by harvesting at the end of April (5.56 kg/tree). Similar trend in yield of dry sticklac and seedlac was found. The lowest yield of fresh sticklac (4.26 kg/tree) was obtained when harvested at the end of June, identically followed by harvesting at mid-June (4.38 kg/tree). There was no significant difference in the yield of lac when harvesting was done at mid-April (4.73 kg/tree) and at the end of May (4.81 kg/tree). Percentage of seedlac production from dry sticklac was the highest (64.15%) when harvesting was done at the end of April. The number of lac insect population at different harvesting times varied significantly, though they were non-significant at initial stage. The mortality of lac insect ranged from 77.80 - 86.70% at different harvesting time of baishakhi lac crop. The lowest and the highest mortality of lac insect were found when harvesting was done at mid-April and end of June, respectively.

Determination of pre-harvest interval for fenitrothion, fenvalerate and acephate in major vegetables

The study was conducted to determine the per-harvest interval (PHI) for fenitrothion in tomato; fenvalerate in hyacinth bean and acephate in tomato and cauliflower depending on Maximum Residue Limit (MRL) set by FAO/WHO. Four supervised field trials were conducted and sprayed with the recommended dose of acephate (2g/L of water), fenitrothion and fenvalerate (1mL/L of water). Samples were collected at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16 days after spray (DAS). The quantities were above MRL up to 7 DAS for fenitrothion in tomato; 9 DAS for fenvalerate in hyacinth bean; 9 DAS for acephate in tomato and 11 DAS for acephate in cauliflower. No residue was detected at 10 DAS for fenitrothion in tomato; 14 DAS for fenvalerate in hyacinth bean and for acephate 14 DAS in tomato and 16 DAS in cauliflower. The PHI was determined at 8 DAS for fenitrothion in tomato; 10 DAS for fenvalerate in hyacinth bean and for acephate it was 10 DAS in tomato and 12 DAS in cauliflower.

Quantification of residue degradation of fenvalerate and acephate in major vegetables under supervised field trial

The study was carried out to detect and quantify the left over residue of acephate in yard long bean; fenvalerate in tomato and yard long bean for the comparison between the detected residue levels with Maximum Residue Limit (MRL) set by FAO/WHO. Three supervised field trials (one for acephate and another two for fenvalerate) were undertaken sprayed with the field dose of fenvalerate @ 1ml/l of water and acephate @ 2g/l of water. Samples were collected at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 days after spray (DAS). The residue of acephate was detected up to 13 DAS in yard long bean and the residue of fenvalerate detected up to 12 DAS in tomato and 13 DAS in yard long bean, of which up to 11 DAS the quantities of residue of acephate were above MRL in yard long bean; 9 DAS in tomato and 11 DAS in yard long bean in case of fenvalerate. Acephate remained 0.384-0.026 mg/kg residue in yard long bean which were below MRL at 12 to 14 DAS. No residue was detected in the sample of yard long bean at 15 DAS. Fenvalerate contained 0.076-0.008 mg/kg residue in tomato, 0.049-0.021 mg/kg residue in yard long bean which were below MRL at 10 to 12 DAS in tomato and 12 to 13 in yard long bean which were also below MRL. No residue was detected at 13 DAS in tomato and 14 DAS in yard long bean.

Determination of pesticide residue in selected vegetables collected from different regions of Bangladesh

In order to detect and quantify the left over residue of five commonly used pesticides (chlorpyriphos, quinalphos, diazinon, acephate and dimethoate) in different vegetables like yard long bean, brinjal, hyacinth bean, tomato, chilli, cabbage, cauliflower and okra samples collected from local market of ten different locations viz. Jessore, Comilla, Norsingdi, Bogra, Rajshahi, Rangpur, Mymensingh, Jamalpur, Barishal, Dhaka and comparison between the detected residue level with maximum residue limit (MRL) set by FAO/WHO. Among 78 analyzed samples of yard long bean, 11 samples were contaminated with quinalphos, chlorpyriphos, acephate and dimethoate residue. Tewnty four per cent samples had contaminated with single (11.54%) or multiple (2.56%) insecticide residues, of which 6% samples were of above MRL with chlorpyriphos and quinalphos residue. Quinalphos had 0.409 mg/kg residue which was 2 times higher than MRL value in Rajshahi location. Sample of Norsindi showed 9% higher quinalphos residue and Jamalpur contained 7% higher chlorpyriphoe residue then MRL. Out of 78 analyzed samples of bean 7 samples contained with single insecticide (dimethoate, diazinon and quinalphos) residue and 2 samples had multi product (chlorpyriphos and quinalphos) residues. Among 12% contaminated samples, 3% samples were of above MRL. One sample from Jessore location had 0.512 mg/kg quinalphos residue and another from Narsindi had 0.573 mg/kg dimethoate residue which were about 3 times higher than MRL value. Among 30 analyzed samples of bitter gourd, 3 samples were contaminated with quinalphos and chlorpyriphos residues, of which 3% contained 0.217 mg/kg quinalphos residue which was above MRL in Bogra location. Among 30 analyzed samples of cabbage 10% were contemainated with chlorpyriphos residue (0.21-0.37 mg/kg) which was above MRL collected form Jessore, Bogra and Norsindi locations. But a total of 190 anlyzed samples of brinjal, chilli, tomato, okra and cauliflower, no pesticide residue were detected. The presence of pesticide residue exceed MRL in vegetables is very harmful to human food safety.

Development of analytical method for pesticide residue determination using liquid chromatography triple quadrupole mass spectrometry

Two analytical methods were developed for the determination of thiamethoxam and dimethoate using Liquid Chromatography triple quadrupole Mass Spectrometry (LC-MS/MS). The heated electrospray ionization (HESI) mode was used to develop the method. The linearity of the developed analytical methods was very good and it was 0.998 for both of the selected pesticides. The optimization of MS/MS parameters has been done properly for both the selected pesticides through direct infusion of 100 µg/L standard solutions.

Monitoring of multiple pesticide residues in major fruits collected from different regions of Bangladesh

The study was conducted to analyze multiple pesticide residues in mango, litchi, guava and ber collected from different locations of Bangladesh. A simple and efficient multiple pesticide residue analytical method using Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) extraction technique and Gas Chromatography (GC) coupled with Flame Thermionized Detector (FTD) and Electron Capture Detector (ECD) were used for the determination of pesticide residues in 105 samples of mango, 101 samples of litchi, 25 samples of guava and 18 samples of ber. A total of 249 fruit samples were analyzed. Among the analyzed samples of different fruits, 3 samples of mango were contaminated by cypermethrin and the level of detected cypermethrin residues were below MRLs, 4 samples of litchi were contaminated by cypermethrin and chlorpyrifos and the level of detected cypermethrin and chlorpyrifos residues were above MRLs, 1 sample of guava was contaminated by cypermethrin, which was above MRL and 1 sample of ber was contaminated by chlorpyrifos, which was also above MRL. This study reflects the scenario of pesticide residue contamination in the selected fruits collected from different locations of Bangladesh, which will help the consumer to be aware of their health and safety.

Monitoring of multiple pesticide residues in betel leaf collected from different regions of Bangladesh

An easy and efficient multiple pesticide residue analytical method using Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) extraction technique and Gas Chromatography (GC) coupled with Flame Thermionized Detector (FTD) and Electron Capture Detector (ECD) were used for the determination of 7 organophosphorus and 2 synthetic pyrethroid pesticide residues in the samples of betel leaf collected from different locations of Bangladesh. A total of 40 samples were analyzed. Among the analyzed samples of betel leaf, 3 were contaminated with cypermethrin at a level ranged from 3.80 to 5.11 mg/kg. The level of detected cypermethrin residues were above MRLs. This study reflects the scenario of pesticide residue contamination in betel leaf collected from different locals of Bangladesh.

Monitoring of multiple pesticide residues in water using quechers extraction and gas chromatography

A simple and efficient multiple pesticide residues analytical method using QuEChERS extraction and Gas Chromatography coupled with Electron Capture Detector (ECD) has been used to determine 19 organochlorine pesticides in drinking water. The water samples were collected from different regions of Bangladesh and carried to the Pesticide Analytical Laboratory for the identification and quantification of selected pesticide residues in water. A total of 26 samples were analyzed. Among the analyzed samples, none of them contained selected pesticide residues.

Validation of a method for estimation and decontamination of fenvalerate residues in country bean (*Lablab purpureus*)

Validation of an effective analytical method for the residue analysis of fenvalerate and its decontamination in country bean (*Lablab purpureus*) were studied. The extraction and cleaned up were done with QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) method and determined by Gas chromatography with electron captured detector (GC-ECD). At four fortification levels of 0.05, 0.1, 0.2 and 0.3 mg/kg in country bean was shown that recoveries ranged from 82.0 to 90.38 % with precision in case of repeatability (RSDr) of 1.10 to 7.32 %. The limit of detection (LOD) and limit of quantification (LOQ) were found to be 0.006 and 0.05 mg/kg, respectively. However, the decontamination study also accomplished, which specified that, dipping in 5% salt (NaCl) solution and dipping in 2% backing soda ($NaHCO_3$) solution could reduce upto 56-80% and 51-87% fenvalerate residues in country bean respectively. It also can be revealed that fenvalerate likely to hydrolyse in alkaline and salty media. This study may help to standardize simple cost effective strategies to eliminate fenvalerate residues from country bean in 0-3 days after spray (DAS) which could be practiced by homemakers.

Validation of a method for estimation of pesticides residue in marketed dry fish

Validation of an effective analytical method for the residue analysis of nineteen organochlorine pesticides in dry fish was studied. Nine popular dry fish were collected from seven different region of Bangladesh. The extraction and cleaned up was done with QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) method and determined by Gas chromatography with electron captured detector (GC-ECD). At fortification levels of 0.05, 0.1, 0.2 and 0.3 mg/kg in dry fish, it was shown that recoveries ranged from 87.2 to 115.6 % with precision in case of repeatability (RSDr) of 1.03 to 13.57 %. The limit of detection (LOD) and limit of quantification (LOQ) were set up to 0.005 and 0.05 mg/kg, respectively. On the other hand, 21.62% of analyzed dry fishes were contaminated with alpha BHC, 4,4 DDE, diazinon, dimethoate, chlorpyriphos and acephate. Moreover, three samples were contaminated with multi pesticide (churi, chepa and loitta) and maximum contamination was occured in dried fishes collected from Jessore & Bogra. The residues ranges from 0.015 to 0.158 mg/kg of 4,4 DDE were estimated in loitta, cheap and kanchki. Residues of three samples, contaminated with 4,4 DDE are in above MRL. In addition, the residues of alpha BHC was ranges from 0.043 to 0.149 mg/kg and none of them are in above MRL. On the other hand, the organophosphorus pesticide residues were ranges from 0.554 to 2.379 mg/kg, 0.0293 to 0.041 mg/kg, 0.268 to 0.282 mg/kg and 0.167 mg/kg of chlorpyrifos, diazinon, dimethoate and acephate, respectively. Among them, 2 samples were in above MRL. Churi dry fish collected from Dublarchar showed about five time's higher residues than MRL.

Purity analysis of different marketed pesticide groups

The study was undertaken to determine the purity of available marketed brands of seven selected pesticide groups collected from local markets of eight different locations. The total number of pesticide brands of seven different groups was 52 and 73% of the tested brands were found more than 90% pure in terms of active ingradient (AI) presence. The purity range of about 19% of the total tested brands was 51-80% pure. And the remaining 8% were equal or less than 50 % pure, of which one brand did not contained any AI.

HARS Khagrachari

Evaluation of jackfruit germplasm in the hilly region

Evaluation of eleven jackfruit germplasm was done at fruit farm of HARS, Khagrachari during 2016-17 to identify superior small sized jackfruit germplasm with high yield potentiality and edible qualities. Yield and yield components of the jackfruit germplasm revealed that number of fruits per plant ranged from 33-121. AH Kha-004 produced the maximum number of fruits (121) followed by AH Kha-002 (103) and the minimum was recorded in AH Kha-009 (33). Among the eleven germplasm, six produced more than 75 fruits per plant indicating high yielding potentiality. Single fruit weight ranged from 2.65-4.63 where AH Kha-003 produced the highest (4.63 kg) individual fruit weight followed by AH Kha-001 (4.59 kg) and the lowest was found from AH Kha-009 (2.65 kg). TSS content of the fruit varied from 17-23. AH Kha-005 and AH Kha-010 produced the highest TSS (23%). Yield (kg/plant) was found the highest (453.75 kg) in AH Kha-004 and lowest in the line AH Kha-009 (87.45 kg). The edible qualities varied from (32.83-52.52) % where AH Kha-010 showed the highest (52.52%) followed by AH Kha-011(52.38%) and the lowest was observed in AH Kha-009 (32.83).

Performance of mango (Kanchamitha) germplasm at hilly region

An experiment was conducted for the evaluation of one Kanchamitha mango germplasm (MI-Kha 001) at the Hill Agricultural Research Station, Khagrachari during 2016-17.The full blooming period was second week of January. The tree habit was spreading to intermediate type. Fruit harvesting period was 28 April 2017. Total Soluble Solid (TSS) was noted 9.0. Edible portion was found (70.37%). Overall growth condition of the germplasm was found satisfactory. Considering the fruit characters and edible quality MI-Kha 001 was considered as a promising mango genotype for used as unripe condition.

Performance of dragon fruit germplasm at hill slope

The experiment was carried out at HARS, Khagrachari to determine the performances of Dragon fruit germplasm in the hill slope. The maximum individual fruit weight (390 g) was recorded from BARI Dragonfruit-1 followed by HU Kha-002 (303 g) but the minimum (213 g) in HU Kha-001 The highest number of fruits per pillar (24) was observed in BARI Dragonfruit-1 and the lowest in HU Kha-001 (9). The highest edible portion (87.81%) was obtained from BARI Dragonfruit-1, whereas the lowest (78.75%) in HU Kha-001. The maximum TSS (14%) was found in BARI Dragonfruit-1 and HU Kha-001 while the lowest (12%) in HU Kha-002.Considering flowering time and fruit bearing habit, fruit characteristics i,e taste, juiciness, sweetness, colour of pulp and yield, all the three germplasm may be suitable for cultivation in hill slope However, for commercial cultivation, it needs more study with economic analysis and marketing potentiality.

Evaluation of indegenous ber germplasm at Khagrachari

A study was conducted at the Hill Agricultural Research Station in Khagrachari hill district on thirty one local ber genotypes during August 2016 to March 2017. Average individual fruit weight ranged from 4.5 to 16.8 g. The genotype ZM Kha-32 produced the highest individual fruit weight (16.8 g) followed by ZM Kha-031(13.9 g) and the lowest in ZM Kha-002(4.5g). Fruit length of different genotypes varied from 1.87 cm (ZM Kha-029) to 2.99cm (ZM Kha-032) whereas fruit breadth ranged from 1.8 cm (ZM Kha-010) to 2.89 cm (ZM Kha-030). Edible portion ranged from 52.6% (ZM Kha-026) to 93.41% (ZM Kha-031). TSS varied from 10.40% (ZM Kha-026) to 24.2% (ZM Kha-011).

Evaluation of jamun germplasm at HARS Khagrachari

Twenty jamun germplasm evaluated for their fruit characteristics at the existing plantation in the fruit orchard of HARS, BARI Khagrachari during 2015-16 & 2016-17. The maximum size and weight of individual fruit was in SC Kha-006 and the minimum was in SC Kha-008. Out of twenty seven germplasm showed their superiority in respect of fruit size. The edible portion of the different germplasm also varied widely and ranged from 73.21% – 93.10%. The TSS % of the germplasm ranged from 12% -15.6%. Considering of fruit characteristics, edible quality, TSS, percent edible portion and yield potentialities, the germplasm SC Kha-007, SC Kha-008, SC Kha-005, SC Kha-014 and SC Kha-015 were found promising.

Evaluation of collected cashewnut germplasm at HARS Khagrachari

The experiment was carried out at HARS, Khagrachari to determine the performances of cashewnut germplasms in the hill slope. Number of fruits per plant was maximum in AO Kha-002 (655) and minimum in AO Kha-001 (570). The highest apple weight (36.8 g) was recorded in AO Kha-002 and lowest in AO Kha -001 (570 g). Apple length was highest (4.7 cm) in AO Kha -002 and lowest (4.3) in AO Kha-001.The maximum breadth (3.98 cm) was observed in AO Kha-002, whereas the minimum (3.55 cm) in AO Kha-001. The maximum apple weight/plant (24.14 kg) was recorded from AO Kha-002 followed by AO Kha-001 (15.04 kg). The maximum apple TSS (11.5%) was found in AO Kha-002 and the lowest (10.8%) in AO Kha-001. Individual nut weight was observed maximum (5.4 g) in AO Kha-002 and minimum (4.2 g) in AO Kha-001. Nut length was maximum (3.05 cm) in AO Kha-002 and lowest (2.92 cm) in AO Kha-001.The maximum breadth (2.2 cm) was observed in AO Kha-002, whereas the minimum (1.8 cm) in AO Kha-001. The maximum nut weight/plant (3.54 kg) was recorded from AO Kha-002 followed by AO Kha-001 (2.40 kg). The edible portion (37.5%) was found maximum in AO Kha-002 and the lowest (36.2 %) in AO Kha-001.

***In-situ* evaluation of year round pummelo germplasm**

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari during the year 2016-17. One off-season pummelo germplasm (CG Kha-001) was selected for the evaluation along with a normal season control. Mainly two season bearing occurred in the germplasm. Fruit weight ranged from 1.57 kg to 1.18 kg. The maximum edible portion was obtained from the control (48.02%) with the highest TSS (10%) while it was 39.14% in the off-season line with a TSS value of 9.0%. The highest number of fruits (154) was collected from CG Kha-001.

Growth, yield and quality of mandarin as influenced by fertilizer application, methods and amount of irrigation in the hilly region

An experiment was conducted at Hill Agricultural Research Station, Khagrachari on the existing orchard to find out the growth, yield and quality of mandarin influenced by fertilizer application, methods and amount of irrigation in the hilly region of Bangladesh. The experiment was set up during December 2016 at 4 years old orchard of mandarin (var. BARI Komola-2). Plant to plant spacing was about 5m × 5m. Six treatments were distributed in a Randomized Complete Block Design with 4 replications. The treatments were T_1: Farmers' practice; T_2, T_3 and T_4 consisted of irrigation by ring basin method at 15 days interval (November-May) with fertilizer applied at 2, 3 and 4 months interval, respectively; T_5 and T_6 were of drip irrigation at 5 days interval (November-May) with fertilizer application at 2 and 1 month's interval, respectively. As the experiment was started when fruits attained maturity, it is obvious that the treatments could not contribute to growth, yield and quality of mandarin. However, initial data of the plants viz. canopy length, plant height and stem diameter were taken. This is an on-going experiment, therefore, effects of the treatments will be visible after this year's harvesting of fruits. Further observations will be made in the next years.

Evaluation of mandarin germplasm in the hilly region

The experiment was conducted to study the performance of mandarin germplasm collected from different locations and planted at HARS, Khagrachari. Three sets of germplasm were evaluated to identify promising mandaring germplasm in respect of fruit bearing, fruit quality and yield potentiality. All the germplasm produced profuse fruit per plants except CR Kha-1-02, CR Kha-1-090 and CR-Kha-1-038. Individual fruit varied from 52.89-158g. The biggst fruit was recorded in CR-Kha-1-044. The germplasm CR-Kha-1-002, 003, 004, 018, 030, and 092 were inferior in respect of individual fruit weight. The TSS% of the germplasm ranged from 7.5 to 9.0. Considering the fruit bearing, fruit weight and TSS% content the germplasm CR-Kha-1-044, 042, 029 & 001 and were found promising.

HTARS Ramgarh

Evaluation of Indian dillenia germplasm in hilly region

Three Indian dillenia germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2016. The line DI RAM 003 produced the maximum number of fruits (597/plant) while heavier fruit (801.7 g/fruit) was produced by the line DI RAM 005. The maximum fruit yield (430.40 kg /plant) was obtained from the line DI RAM 005 and the lowest yield (106.21kg/plant) was recorded in DI RAM 002.

Evaluation of golden apple germplasm in the hilly region

Seven Golden apple germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2016. The line SDRAM 001 produced the maximum number of fruits (3388/plant) while heavier fruit (102.6 g/fruit) was produced by the line SD RAM 002. The maximum fruit yield (309.33 kg /plant) was obtained from the line SD RAM 002 and the lowest yield (17.3kg/plant) was recorded in SD RAM 006.

Evaluation of advanced sapota germplasm

Three sapota germplasm were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2017. The line AS RAM 005 produced the maximum number of fruits (506/plant) while bigger fruit (173.3g) was produced by the line AS RAM 001. The maximum fruit yield (54.58 kg/plant) was obtained from the line ASRAM 001 and the maximum TSS (20.6%) was recorded in ASRAM 004.

Evaluation of star gooseberry germplasm in hill region

Five germplasm of star gooseberry fruits were evaluated at Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2017. The higher number of fruits (620/plant) was found from PA RAM 001 and weight of fruits (3.06 kg/plant) was harvested from the same germplasm and TSS (%) was almost similar in both germplasm.

Evaluation of monkey jack germplasm in hilly region

Five germplasm of monkey jack fruits were evaluated at Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2017. The maximum number of fruits (322) was found from AL RAM 001 and weight of fruits (59.962 kg/plant) was harvested from the same germplasm and TSS (%) was also the highest (16.76%) in AL RAM 001.

Evaluation of malta germplasm in hilly region

Two germplasm of Malta were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2016. The maximum number of fruits (135.7), weight of fruits (24.52 kg) was obtained from the germplasm CS RAM 001 and TSS was higher (8.10 %) in BARI Malta-1followed by CS RAM 001 (7.80 %).

Evaluation of colourd malta germplasm in hilly region

Thirty germplasm of colored Malta were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2017. Plant height, base girth, number of main branch/plant, plant spread (N-S), Plant spread (E-W) range were 1.56-2.23, 4.5-10, 1-3, 50-110 and 60-85, respectively.

Evaluation of China mandarin germplasm in hilly region

Forty germplasm of China Mandarin were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2017. Plant height, base girth, number of main branch/plant, plant spread (N-S), plant spread (E-W) range were 1.32-2.22m, 6.8-9.2cm, 2.0-3.0, 85-121cm and 80-145cm respectively.

Performance of Tisa germplasm in the hilly region

Five germplasm of Tisa fruits were evaluated at Hill Tracts Agricultural Research Station, Ramgarh during the year 2017. The maximum number of fruits (171), weight of fruits (19.04 kg) was obtained from the germplasm PC RAM 003 and TSS (%) was also recorded highest (22.5%) in PCRAM 003 followed by PCRAM 005 (22.4%).

Evaluation of jaboticaba germplasm in hilly region

Five germplasm of Jaboticaba fruits were evaluated at Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during April, 2017. The maximum number of fruits (325) was found from EC RAM 002 but weight of fruits (2.2 kg/plant) was harvested from the germplasm EC RAM 004 and TSS (%) was also the highest (11.9%) in EC RAM 003.

Evaluation of cashewnut germplasm in hilly region

Five cashew nut germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh during the year 2017. The line AQ RAM 005 produced the maximum number of fruits (802/plant) while heavier nut (5.8 gm) was produced by the line AQ RAM 001. The maximum nut yield (3.84 kg/plant) was obtained from the line AQRAM 005 and the maximum edible portion of nut (37.2%) was recorded in AQ RAM 004.

Evaluation of coloured flesh (binny) jackfruit germplasm in the hilly region

The experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2016-17. The maximum yield per plant (276.5 kg) was obtained from AH RAM 001(C) followed by AH RAM 002 (C) (225.6 kg) and it was the lowest in AH RAM 003 (C) (36.0 kg). The highest edible portion was found in AH RAM 001 (C) (48.3%) and the lowest was obtained from AH RAM 003(47.3%).

Performance of grafted and seedling plants of jackfruit var. BARI Kanthal-2

The experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2017 to observe the performance of grafted and seedling plants of BARI Kanthal-2. Average plant height (541 m), number of branch/plant (2.0), base girth (57cm) were found from grafted plant. In case of seedling plant, average plant height (8.03 m), number of branch/plant (2.32), base girth (70cm) were recorded. Number of fruits was maximum in grafting plants (8.0/plant) compared to seedling plants (4.0/plant).

Perfomance of grafted and seedling plants of Velvet apple var. BARI Bilati Gab-1

The experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2016 to observe the performance of grafted and seedling plants of BARI Bilati gab-1. Average plant height (1.24 m), number of branches/plant (8.80), base girth (19.1 cm) were found from grafted plant. In case of seedling plant, average plant height (4.67m), number of branches/plant (6), base girth (26.4 cm) were recorded. The higher number of fruits (24.4/plant) was obtained from grafted plant compared to seedling plant (20.0/plant).

Perfomance of grafted and tissue culture plants of BARI Malta-1

The experiment was conducted at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari during 2016-17 to observe the performance of grafted and tissue culture plants of BARI Malta-1. Average plant height (2.24 m), number of branch/plant (2.25), base girth (17.5 cm) was found from grafted plant. In case of tissue culture plant, average plant height (2.63 m), number of branch/plant (2.50), base girth (18.0 cm) was recorded. Higher number of fruits (46.6) was found from tissue culture plants compared to grafted plants (33.2/plant).

ARS Raikhali

Performance of BARI released mango varieties in Chittagong hill tracts

An experiment was conducted on the existing nine years old mango orchard with BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4 and BARI Aam-8 at hill valley of Hill Agricultural Research Station at Raikhali in Rangamati Hill District during 2016-17 to verify their performance. The maximum plant height (695 cm), and yield (19.7 t/ha) were observed in BARI Aam-8. The heaviest fruit (439.3 g), highest edible portion (76.1%) as well as yield (17.6 t/ha) were found in BARI Aam-4. The maximum TSS (21.3%) and the highest fruits per plant (303.3) was recorded in BARI Aam-3. The lowest number of fruits per plant (101.3), edible portion (66.9%) and fruit yield (5.4 t/ha) were found in BARI Aam-1.

Evaluation of kachamitha mango germplasm at hill valley in Chittagong hill tracts

An experiment was conducted on the existing four years old mango orchard with MIRai005, MIRai006, MIRai007 and MIRai008 genotypes at hill valley of Hill Agricultural Research Station of Raikhali, Kaptai in Rangamati Hill District during 2016-17 to find out the best kachamitha mango genotype. The highest number of fruits per plant (70) was found in MIRai007 and the lowest number of fruits per plant (30) was in MIRai005. The heaviest individual fruit weight (226.52 g) was recorded in MIR008 and the highest edible portion (78.65%) were found in MIRai008 on the other hand lowest fruit weight (97.97 g) and lowest edible portion (72.9) were found in MIR007. The maximum TSS (9%) was found in MIRai005 and the minimum TSS (7%) was found in MIR007. Genotype MIR008 was found very well in organoleptic test.

Effect of bagging on yield and quality of mango in hilly area

An experiment was conducted at the existing eight years old mango orchard of BARI Aam-3 at hill valley of Hill Agricultural Research Station at Raikhali in Rangamati Hill District during 2016-17. The minimum fruit drop (3.3%), insect infestation (nil), disease infection (10%), birds attack (nil), maximum individual fruit weight (241g) and self life (8 days) was found in China bag (brown). Marketable mango (96.7%) as well as grade-1 mango (86.7%) also maximum in China bag (brown). On the other hand, minimum number of marketable mango (60%) was found in control treatment but minimum shelf life (2 days) was recorded in polythene bags.

Effect of post-harvest pruning on maintaining tree size and quality yield of mango in hilly area

An experiment was conducted at the existing nine years old mango orchard of BARI Aam-3 at Hill Agricultural Research Station at Raikhali in Rangamati Hill District during 2016-17. Maximum number of shoot (3.9) was developed from the plant which was pruned 40 cm from the shoot apex. In contrary minimum shoot (2.5) was developed from P_1 (10 cm) treatment. Average number of fruits per plant (243) was also highest in P_5 (40 cm) treatment and lowest (190) in P_2 (10 cm) treatment. The heaviest individual fruit (232.3 g), maximum fruit length (9.1 cm), fruit breadth (6.1 cm), thickness (5.6 cm), edible portion (68.3%) and fruit yield (13.8 t/ha) were was recorded in P_4 (30 cm) treatment, whereas the lightest individual fruit (178.3 g), minimum fruit length (8.6 cm), fruit breadth (5.9 cm) and thickness (5.3 cm) were found in control treatment (without pruning). The highest TSS (22.1%) was recorded in P_3 (20 cm) treatment and the lowest (19.4%) in P_2 (10 cm) treatment. The minimum fruit yield (10.3 t/ha) was recorded in control treatment (without pruning).

Evaluation of jamun (*Syzygium cumini)* in hilly area of Rangamati

An experiment with four jamun genotypes was conducted on three years old jamun genotypes established in minor fruit block of Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2016-17. The highest number of fruits per tree (1733) as well as yield per plant (23.6 kg) was recorded in SCRai004 but the lowest fruits (870) found in SCRai008. On the other hand, the maximum fruit size (3.3 cm × 2.8 cm), individual fruit weight (14.2 g), flesh thickness (9.23 mm), edible portion (85. 2%) and TSS (18.4 %) were recorded in SCRai009. Fruits of all the genotypes were black in color, oblong in shape with flat fruit apex. The organoleptic test of SCRai008 was very well in taste.

Evaluation of bael (*Aegle marmelos*) in hilly area of Rangamati

An experiment for the evaluation of bael in hill valley was conducted at Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District during 2016-17. The AMRai003 produced 21 fruits, each fruit weighing 1450 g. Edible portion and TSS were 70.7% and 37.7%, respectively. Bitterness was completely absent, very sweet and organoleptic test was very good.

Evaluation of wood apple (*Feronia limonia*) in hilly area of Rangamati

An experiment on the evaluation of wood apple in hill valley was conducted with four genotypes at Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District during 2016-17. Maximum number of fruits (135), yield per plant (60.8 kg) and edible portion (57.9 %) was found in FLRai003 germplasm and it was very well in organoleptic test.

Evaluation of phalsa (*Grewia asiatica L.*) in hilly area of Rangamati

An experiment on the evaluation of phalsa in hill valley was conducted at the established minor fruits orchard of Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2016-17. Maximum number of fruits per plant (13800), fruit length (9.28 mm) and fruit yield (3.3 t/ha) was found in the genotype GARai002 on the other hand the highest TSS (25.6 %) was recorded in the genotype GARai004.

Validation trial of tissue cultured plantlets of malta under field condition

An experiment on the validation trial of tissue cultured plantlets of malta under field condition in hill valley was conducted at Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District during 2016-17. The tissue cultured malta produced thorn on its whole branches whereas grafted malta was totally thorn less. Tissue cultured malta produced fruit when it was five years plant but grafted malta can harvest after three years. Average fruits per plant in tissue cultured malta was 41.3 on the other hand 193.7 for the grafted malta.

Evaluation of pummelo (*Citrus grandis* Osbeck) in hilly region of Rangamati

An experiment with twelve genotypes of pummelo was conducted at the existing nine years old pummelo orchard collected from different parts of Chittagong Hill Tracts at hill valley of Hill Agricultural Research Station of Raikhali in Rangamati Hill District during the period of 2016-17 for the evaluation of superior pumelo lines in hilly region. The maximum number of fruits per plant (130) was observed in CGRai005 followed by CGRai010 (96), whereas the minimum (59) in CGRai023. The earliest flowering (mid February) was recorded in CGrai002 and the latest (mid March) in CGRai026. Quality fruit was observed in CGrai006, CGrai010, CGrai023 and CGrai028 by organoleptic test.

Collection and evaluation of citrus fruit germplasm from hilly areas

A total of 50 citrus germplasms were selected through preliminary evaluation from two Citrus Fruit Shows held in Rangamati and Bandarban Hill District collected from these two districts and other places even from foreign country during 2013-16. Among collected germplasm, 19 germplasm were pummelo, 15 were mandarin, 03 were sweet orange, 08 were lemon and 04 were lime. Minimum three (03) of each collected genotypes were transplanted to main field during 2014, 2015 and 2016.

OFRD Bandarban

On-farm trial of BARI hybrid maize varieties in hilly areas

The trial was conducted at Kyamlong para hill valleys in Bandarban during the *rabi* season, 2016-17 to compare the performance of BARI developed hybrid maize varieties with commercial maize cultivars. Four varieties were evaluated including three BARI developed hybrid maize varieties viz., BHM (BARI Hybrid Maize)-5, BHM-7 and BHM-9 with NK-40 as a check variety. The experiment was laid out in RCB design with three dispersed replications in the farmer's field. The unit plot size was 6m × 5m. Spacing was 60cm × 20cm. Seeds of different varieties were sown on 21-23 November, 2016. The crop was fertilized with 250-55-110-40-5-1.5 kg N-P-K-S-Zn-B ha^{-1}. The crop was harvested at maturity on 18-20 April, 2017. The crop was irrigated at 20-40-70 days after sowing (DAS) and at grain filling stage. Yield and yield attributes were recorded and analyzed statistically using Web Agri Stat Package (WASP). Commercial variety NK-40 gave the highest yield (9.61 t ha^{-1}) followed by BHM-9 (9.28 t ha^{-1}). BHM-5 gave the lowest yield (8.05 t ha^{-1}). BHM-9 and NK-40 both gave the highest no. of cob m^{-2} (10.2) which was more profitable for the farmers of this region whoever consumed boiled or roasted whole cob at a time. Generally farmers of Chittagong hill tracts harvest the cob at dough stage and consume as boiled and roasted cob. The higher cob producing capacity is their prime need rather than grain yield. Therefore, BHM-9 was equally welcomed by the farmers with NK-40 for higher number of cob yielding performance.

On-farm trial of BARI wheat varieties in hilly areas

The trial was conducted at Bakichara and Kyamlong para hill valleys in Bandarban during the *rabi* season, 2016-17 to compare the performance of BARI developed wheat varieties Four varieties were considered as test material viz. BARI Gom-25, BARI Gom-26, BARI Gom-29 and BARI Gom-30. The experiment was laid out in RCB design with three dispersed replications in the farmer's field. The unit plot size was 5m × 4m. Spacing was maintained 20cm × continuous seeds in line. Seeds of different varieties were sown in different farmer's field on 12-14 December, 2016. The crop was fertilized with 100-35-25-20-1 kg N-P-K-S-B ha^{-1}. Two times weeding were done just before first (20 DAS) and second (55 DAS) time irrigation applied. Third irrigation was applied at seed formation stage (75 DAS). The crop was harvested at full maturity when the stalk and spikes got glittering brown color on 28-30 March, 2017. Yield and yield attributes were recorded and analyzed statistically using Web Agri Stat Package (WASP). Among the four varieties, the highest grain yield was recorded in BARI Gom-30 (3.05 t ha^{-1}) which differed significantly from other varieties. The lowest grain yield was obtained from BARI Gom-26 (1.88 t ha^{-1}). BARI Gom-30 gave the highest yield because of its higher number of spike m^{-2} and number of seeds $spike^{-1}$. The grains of BARI Gom-30 were bold and heavier than the other varieties. Wheat is a new crop to the farmers of Bandarban. They did not cultivate wheat before. Though this was the first time for them but they have shown interest to grow BARI Gom-30 for its high yielding (3.05 t ha^{-1}) performance.

On-farm trial of BARI Kaon varieties in hilly areas

The trial was conducted at Kyamlong para hill valleys in Bandarban during the *rabi* season, 2016-17 to compare the performance of BARI developed kaon (foxtail millet) varieties. Three varieties were considered as test material viz. BARI Kaon-1, BARI Kaon-2 and BARI Kaon-3. The experiment was laid out in RCB design with three replications in the farmer's field. The unit plot size was 4m × 3m. Spacing was maintained 25 cm × 8-10 cm in line. Seeds were sown in farmer's field on 19 January, 2017. The crop was fertilized with 105-75-40 kg N-P-K ha^{-1}. The crop was harvested at full maturity when the panicle got straw color on 10-20 May, 2017. Yield and yield attributes were recorded and analyzed statistically using Web Agri Stat Package (WASP). Among the three varieties, the highest grain yield was recorded in BARI Kaon-2 (1.86 t ha^{-1}) which differed significantly from other varieties. The lowest grain yield was obtained from BARI Kaon-3 (1.72 t ha^{-1}). Kaon is generally cultivated in jhum field as a mixed crop but not as a sole crop in rabi season. BARI Kaon-2 was preferred by the farmers to grow in future, if the seeds will be available to them. BARI Kaon-3 may be adaptive for jhum cultivation for its shorter plant height character, which may be adaptive against the strong wind in Kharif (jhum) season and may not be lodged.

On-farm trial of BARI released *Bt* brinjal varieties

A trial was conducted at ten farmers field of Vorakhali, Bakichara, Kyamlong para, Bottoli para and Ramree para of Bandarban Sadar Upazila during the *Rabi* season 2016-17 to evaluate the performance of Bt brinjal variety under farmers' field condition and to popularize them among the farmers. The *Bt* brinjal variety viz. BARI *Bt Begun*-4 was tested against non-*Bt* (ISD-006) among ten farmers field. Plot size was 400 m^2. Non *Bt* brinjal variety ISD 006 was transplanted as border crops with BARI *Bt Begun*-4. The plots were fertilized with 10 t ha^{-1} cow dung, 139, 40, 100, 18, 1.7, 3.58, 33 and 21 kg ha^{-1} N, P, K, S, B, Zn, respectively. Bleaching powder was applied 15 days before final land preparation to control bacterial wilt. The seedlings were transplanted on 10 December to 15 December, 2016. Plant protection measures were taken as required. Other intercultural operations were done as and when necessary. Harvesting of fruits was started from 07 February, 2017. Local farmers harvested the crop twice in a week on the day before hatbar (local market day). At maturity different data were collected. The gross economic return was calculated on the basis of prevailing market price of the commodities. It was observed that, about 43% fruits were damaged fully or partially which could not be marketed whereas 100% BARI *Bt Begun*-4 could be sold for the market. No Brinjal Shoot and Fruit Borer (BSFB) infestation was observed in BARI *Bt Begun*-4. On the other hand 22.25 % shoots and 43.74 % fruits (by wt.) infestation by BSFB was observed in non-*Bt* (ISD-006). Plants were infested with mites, aphids and white fly and controlled successfully by spraying oomite, tufgor and sobicron. Folicur and nutivo were also applied to manage wilting and root rot. Individual fruit weight was higher in BARI *Bt Begun*-4 (195 g) than that of non-Bt (ISD-006) (190 g). The yield of BARI *Bt Begun*-4 (27.32 t ha^{-1}) was about double against *Non-BT* (13.5032 t ha^{-1}). The higher gross return (Tk. 546400 ha^{-1}) and gross margin (Tk. 246000 ha^{-1}) were obtained from BARI *Bt Begun*-4. Farmers are interested to grow BARI *Bt Begun*-4 due to no infestation of BSFB and higher yield potentiality. Farmers opined that BARI *Bt Begun*-4 is soft, palatable but they wanted dark coloured brinjal for higher market price. In future they would try to start growing brinjal earliar (October 2017) than this season, therefore they would get more profit because of early season. Wilting caused a serious problem to the crop.

24 SERVICES OF ASICT

Agricultural Statistics and Information & Communication Technology (ASICT) Division consists of two parts namely Agricultural Statistics (AS) and Information & Communication Technology (ICT). Both the parts have been conducting research works as well as support service activities to BARI scientists in general. Research on Agricultural Statistics and ICT have been conducting through BARI annual research program. Besides, Agricultural Statistics and ICT parts have been implementing the following services.

ICT Services

Web information

BARI developed technologies and related information are being publishing regularly through its own web site (www.bari.gov.bd). In addition to technologies, some important issues like tender circular, job circular, journal, annual report are also hosted as and when necessary. About 907 information have been uploaded on the website during 2016-17.

E-agriculture

BARI has been started on line e-agriculture services to the beneficiaries. Any stakeholder can ask question related to agriculture with the help of on-line e-agriculture facility of BARI web site and Mobile apps. BARI have been giving services on-line feedback through website (www.bari.gov.bd) and Mobile apps to end user. About 259 queries have been received from stakeholders and feedbacks of those queries from relevant centres/divisions of BARI have been uploaded on the website and mobile apps during 2016-17.

Citizen services

BARI has started disseminating technological information to the citizen. Any citizen can come and obtain his/her required agricultural technology information/service directly from citizen services information centre and/or from respective crop centre/research division at BARI.

Web based mail services

BARI has procured its own domain of email connectivity under the name “bari.gov.bd”. At this moment 650 web based email addresses has been assigned under BARI domain. It has been decided to assign email address to all scientists under BARI domain gradually.

Network and antivirus maintenance

ASICT division was giving services on LAN & Antivirus maintenance especially for the head quarter scientists and officers. Rendering 24 hours internet services at BARI head quarters .At present more than 846 computers are connected with network and provided with a corporate version of antivirus. Ensuring hassle free internet connectivity ASICT division has been performing a number of network and antivirus maintenance activities. About 546 network and antivirus related maintenance work have been done during 2016-17.

Wi-Fi connectivity

BARI has been established Wi-Fi connectivity in different places. ASICT division has giving services on Wi-Fi & maintenance especially for the head quarter scientists and officers. At present 300 devices are connected in Wi-Fi network during 2016-17.

Network connectivity at eight outer stations

Network connectivity through Virtual Private Network (VPN) and 1 Mbps broadband internet connection at eight outer stations such as WRC, Dinajpur; SRC, Bogra; RARS Jamalpur; RARS Ishurdi; RARS Jessore; RARS Hathajari; RARS Ramatpur and RARS Akbarpur with MoA have been established.

Innovation

A2i (Access to information), Prime Minister Office and Cabinet Division has been established Public service innovation (নাগরিক সেবায় উদ্ভাবন) for all organization of above Ministry. As a result, ASICT division will be given services on innovation for all scientists at BARI. At present 40 scientists, are trained in public service innovation.

E-Governance

e-filing system

Prime Minister Office has been established e-filing system in BARI head quarter. ASICT division has giving services on e-filing system especially for the head quarter scientists, officers and staffs. At present 137 scientists, officers and staffs are connected in e-filing system.

List of users activity in e-filing system during 1 January to 14 June 2017

	ব্যবহারকারী		ডাক						নথি				
অফিসের নাম	মোট	গড়	মোট গ্রহণ	মোট প্রেরণ	মোট নথিজাত	মোট নথিতে উপস্থাপন	মোট নিষ্পন্ন	মোট অনিষ্পন্ন	মোট স্ব-উদ্যোগে নোট	মোট ডাক থেকে সৃজিত নোট	মোট পত্রজারীতে নিষ্পন্ন	মোট নোটে নিষ্পন্ন	মোট অনিষ্পন্ন নোট
বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট	১৩৭	১০০	১,০৩৮	১,০২৩	২৮০	৩৫২	৬৩২	৪০৮	২১৬	২৬৬	১৫০	৪৭	১২৭

BARI automation through 9 modules (MIS)

This office automation software is divided into nine separate modules viz. Human Resource Management Information System (HRMIS), Training Management Information System (TMIS), Research Management Information System (RMIS), Financial Management Information System (FMIS), Procurement Management Information System (PMIS), Inventory Management Information System (IMIS), Vehicle Management Information System (VMIS), Library Management Information System (LMIS) and Databank (Gene Bank). Each module can be operated solely and has a options to be integrated together as per requirements.

Human resource development

ASICT division has engaged human resources development through various type of training program related to ICT. ASICT division has been conducted six training program namely Training course on e-filing management system, নাগরিক সেবায় উদ্ভাবন, Capacity development for e-management using Unicode and Internet, Data analysis of experimental design using open source R, Financial management system software and Labour management software during 2016-17.

Geographical information system (GIS) mapping

GIS is one of the formalized computer based information systems capable of integrating data from various sources to provide information necessary for effective decision making in urban, rural and agricultural planning. Bangladesh Agricultural Research Institute (BARI) is the largest multi-crop research institute. It conducts research on more than two hundred crops. To know the crop area, crop suitability, crop modeling it is very important. For digital data base and mapping it is unparallel. ASICT division has been prepared about 18 maps for different centres/divisions based on their requirements.

Participation of ICT fair

However besides services ASICT division has been participated 'Information fair' held on 15-16 March 2017@ Rajbari, Gazipur; Brac-Manthan innovation fair held on 22 October 2016 @ Hotel Redission,Dhaka; Digital Innovation Fair held on 25-27 September 2016 @ Bousundhara Interntional Convention Centre, Dhaka and Mobile Apps field day at Chapai Nawabganj sadar upazila in Chapai Nawabganj District. held on 15 January 2017 @ Upazila Agricultural Office, Chapai Nawabganj sadar.

Statistical services

ASICT division has been giving services on statistical analysis through computer package software such as R, SAS, CROPSTAT, SPSS etc. Some important requested analysis has been done about 28 analysis for Center/Division/Section/Others during 2016-17.

Research Outputs 2016-2017

Development of online system for data collection, documentation and mapping of mustard in chalan beel area of Bangladesh

A study was conducted during 2014-17 to build union level digital databases and maps of mustard growing areas in Chalan Beel area, using both primary and secondary data.The results of the study for the years 2014-15 and 2015-16 were presented. The result of the study for the year 2016-17 is presented in this report.. Primary data were collected from mustard growing areas of three upazillas namely Taras of Sirajganj district and Singra and Gurudaspur of Natore district. For mustard: union, upazila, district and country level digitized maps were used in the study. Geographical Information System (GIS), Global Positioning System (GPS) and Management Information System (MIS) related Information Technology (IT) were used in this study. Area and production of mustard were 5415ha and 7488.42t respectively.Five (5) mustard varieties were cultivated in the study areas; among them maximum 5 varieties were cultivated at Sigra and minimum three varieties at Gurudaspur & Taras respectively. Out of 5 varieties of mustard 70.15% area was covered by Tori-7, 17.26% by BARI Sarisha-14, 7.74% by BARI Sarisha-15 and the rest by others. Average mustard yield of the study areas was 1.38 t/ha during 2016-17. It was found that cultivation of BARI mustard vareites is increasing in Chalan Beel area. A web site (www.asictbari.net) was developed for variety wise area coverage data collection of mustard as well as for other crops. This web site could be used in the smart phone.

GIS based digital databases and maps of oilseed crops in Bangladesh

A study was conducted during 2016-17 to build district level digital databases, maps, indexing and availability of major oilseed crops in Bangladesh. Both primary and secondary data were used in the study. In 1969-70, area, production and yield of oilseed crops were 348178 ha, 290600t and 0.83t/ha but in 2015-16 those were 452065 ha, 1080662 t and 2.39 t/ha respectively. After 47 years area, production and yield of oilseed crops have been increased 1.30, 3.72 and 2.86 times respectively. In 1969-70, oilseeds availability was 11.55 gm/h/d but in 2015-16 it was 18.43 gm/h/d but population increased more than double times (2.33) in this period. Digital databases of different parameters such as area, production and yield of oilseed crops were obtained.

Development and implementation of bari labour management system

Labour Management System can manage the labour of an organization effectively and efficiently. A labour management software was developed for monitoring and controlling labour at BARI. This Labour Management System software was developed using MySQL database which mainly focuses on basic operations in labour like adding new labour, updating new information, salary sheet etc. This software is a windows based application for 32-bit windows operating systems, designed to help users maintain and organize labour This software has been designed to use for both beginners and advanced users.

Comparison of spectro-temporal signature of major agricultural crops of Bangladesh

Spectral reflectance indices provide a useful tool for monitoring crop-growing status. This study was conducted during 2014-2017 to identify the features in distinguishing spectro-temporal signature for classifying major crops. A series of spectral data were collected using spectroradiometer from different crop fields such as Potato, Wheat, and Lentil over the crop growing (Rabi) season at BARI research field ancrop meuseum. Analysis was done to assess the spectral separability of various crop types under two scenerios; scenerios 1 involved testing separability based on number of days after planting and scenario 2 involved testing separability at specific dates across the growing season. The results indicate that although crop classification could be achieved at any point during the growing season, the optimal time for separation to be in mid-January. The information derived from hyperspectral radiometer seemed to possess the potentiality for monitoring the general growth status of crop field.

Assessment and Monitoring of Drought in Bangladesh using Remote Sensing and GIS Techniques

Drought is natural hazard which has causing several impacts, such as decreasing of land degradation, forest fire, decreasing of agricultural crops production. Drought assessment using drought indices have widely conducted for drought monitoring. Besides meteorological data based index such as Standardized Precipitation Index (SPI), Remote-sensing-based indices defined as an index which using remote sensing data for mapping the drought condition in particular area or region were used in this study. This research aims to determine remote-sensing-based drought indices, namely Temperature Condition Index (TCI), Vegetation Condition Index (VCI) and Vegetation Health Index (VHI) and SPI for monitoring drought in Bangladesh from 2000-2016. LST and NDVI data were used to construct the indices.

Mapping and Monitoring of Mango Orchards in Rajshahi Region using Satellite Remote Sensing Techniques

The study was conducted to develop an effective technique to extract and monitor mango orchard area from freely available satellite imagery. Current report presents results initial study, that was conducted in 2016-17 with internal funding of BARI as a test case in the Shibganj Upazilla, one of the most important mango producing Upazillas in Bangladesh. Landsat 8 OLI data was classified using SVM data mining approach with support of field derived ground data and google earth imagery. Initial outputs shows the encouraging result with overall 96.4% classification accuracy of the landuse maps. Results of the initial study could be improved by using advanced remote sensing image analysis method for the entire greater Rajshahi districts of Bangladesh with support from newly awarded grant under innovation fund of 2016-17 3rd Round by ICT Division.

25 Training, Communication, Publication Library and Photography Activities

Training & Communication

During 2016-17, nine scientists for Ph.D and 6 (six) scientists for M.S/M.Sc. were sent abroad. One hundred and twenty scientists/officers were sent abroad for training/workshop/study tour/visit meeting/conference etc. Moreover, a good number of scientists were sent to different universities in the country for Ph.D and MS degree.

Seminar

Communication section of T&C arranges seminars in various fields of agricultural research. A total of 2(two) special seminars were organized at BARI during the year 2016-2017 of which one on conservation agriculture and another one on Annual Performance Agreement (APA). A total of 200 participants of BARI were actively participated in these seminars.

MoU and LoA signed

During the period of 2016-17, BARI had signed MoU with 8 (Eight) organizations and LoA with 3 (three) organizations. All of the organizations signed MoU and LoA with BARI were voluntary organization. The purpose of the MoU and LoA were to promote collaboration between agricultural research and development and also for promotion of technology transfer to the end users.

Publication

BARI regularly publishes journal, newsletters (Bengali and English), annual report, books and booklets on the evolved technologies in order to disseminate information to the users including farmers. Brochure, manuals, and other literatures on BARI are also being published. During the year under report, 4 issues of newsletter, brochure of the institute, annual report, a few booklets and some other literatures have been compiled, edited and published. Further, more than hundred science articles revived from scientists of home and abroad has been processed for publication in the journal.

BARI Library 2016-17

A.Mandate: A. Mandate: BARI Library is the biggest Agricultural Library aiming at fulfilling the purpose of its parent institute and is designed to help researchers providing with the information generated in and outside the country in print and electronic form at the right time. Our mandates are as follows:

- Building up a balanced and comprehensive collection in the sphere of agriculture and its allied fields based on the scientists needs with a bit focus on the generalist's interests.
- Preparing and processing the procured materials to ensure users effectiveness.
- Making the research community aware of new information and technology collected in and organized technically.
- Maintaining contract with national and international institutes and organization and sharing the information residing on Internet.

- ❖ Participating inter-library loan and network system to serve the researchers effectively.
- ❖ Providing aid on the use of the library and helping finding, locating and evaluating the information available in the library.
- ❖ Establishing Management Information System (MIS) i.e. digital library, using library management software in the library.
- ❖ Adopting the technique of economic method to preserve and repair the collection to ensure its continued use.
- ❖ Developing the mini-libraries at the regional and sub-regional station to feed the scientists with their needed information.

B. Existing facilities: Information resources materials collected so far have been properly catalogued, classified, and organized. The Library now houses following information resource materials.

1. Existing Collection of BARI Library: 74,789

Items	Quantity
Books, Reports, Proceedings, etc.	35,703
Archival collection	2,670
Thesis	781
Periodicals (bound in book form)	4,247
Journal issues	24,098
Journal titles	621
Newsletter titles	503
Bulletin titles	108
Pamphlets	567
Booklets	164
Reprint	518
Leaflets	4,809

2. Information Resources added during the year 2016-2017:

a. Books, Reports, Proceedings etc. and Thesis: 687

Items	Purchased	Exchange	Gift /Complimentary	Total
Books	523	02	62	587
Research reports, project reports & proceedings	-	28	42	70
Thesis (MS & Ph.D.)	-	-	30	30

b.	**Serial Publications (printed form)**	**Titles**	**Issues**
	Journals:	*29*	*103*
	Newsletters, bulletins etc:	29	123

Items	Purchase	Exchange	Gift /Complimentary	Total
Journals:	8	35	60	103
Newsletters:	-	06	70	76
Bulletins:	-	-	47	47

3. Document Processed for Services:

SI No.	Procured material processed	No.
01	Document Accessioned	687
02	Catalogued & Classified and pasted with call numbers, book pockets and due slips	644

4. Services Provided to the Scientists:

Sl No.	Services provided to the Scientists	Number
1	Article downloaded from Online journal (April 2017)	1,419
2	Documents Charged/Discharges	438
3	Users Referenced	659
4	Number of photocopies made	6,200
5	Publication Distributed (Journal, Newsletter & Report) in Exchange & Complimentary)	895
6	Correspondence made	405

5. Library Database: 502 thesis and monograph have been uploaded on to the LMIS Module, National Agricultural Technical Project (NATP). Our Library database links are as follows:

* 128.15.10.17
* 128.15.10.41

6. Online Browsing Facilities Developed: Library has established online accesses to the subscribe Information resources of 1. Springerlink, Indianjournals, Wiley, Ebscohost, & Cambridge etc and complementary sources are 1. AGORA & HINARI, DOAJ Scientists can have full texts access to thousands of journals published across the world except a few countries through this Online Access. Below are some publisher's addresses:

PERI/INASP

i. http://www.springerlink.com

ii. http://www.indianjournals.com

iii. http://onlinelibrary.wiley.com

iv. http://search.ebscohost.com

v. http://www.journals.cambridge.org

vi. http://www.arjournals.annualreviews.org

vii. **http://www.doja.org**

AGORA & HINARI

viii. http://www.aginternetwork.org

ID: ag-bgd026

Password:

Password: GQ34ACDX

ix. http://www.who.int/hinari

ID: BAN053

Password:

7. BARI Digital Library: BARI library has lunched "**BARI Digital Library**" with the technical assistance of "Islamic University of Technology (IUT) Library". Now this digital library is available for user access through internet from anywhere. The web address is www.baridigitallibrary.org. Here Greenstone library software has used. In this page main icons are:

	Icons	Document uploaded
1.	About BARI Library	3
2.	BARI Journal	1
3.	BARI Publications	13
4.	Books (Gift & Exchange)	-
5.	Books (Purchased)-Password protected	-
6.	Center's Publication	-
7.	Divisional Publications	-
8.	Govt. Publications-Password protected	-
9.	Publications of Hill Agriculture	-
10.	Journal (Purchased)-Password protected	-
11.	Journal (Gift & Exchange)	-
12.	New Arrivals	3
13.	News Clippings	164
14.	Online Journal	-
15.	Proceedings	-
16.	Publications of RARS	-
17.	Reports	-
18.	Thesis –Password protected	5

8. E-book: BARI library has started to prepare E-book with the help of Bangladesh National Scientific & Technical Documentation Centre (BANSDOC).

Photography Section

BARI photography section processing photograph & video clips to ensure effective uses of its parent institute and is designed to help researchers, outside of the Institute in print, soft images and electronic form at the right time.

Activities of photography Section during 2016-2017

Sl. No	Activities	Number
1	Photograph exposed in Digital Camera	26,000 above
2	Photo Editing	17,500 above
3	Video Recording Programme	53

26 BUDGET

Fund for the Institute was received from development and revenue budget of the Government of Bangladesh. The development budget was made available through the annual development program (ADP) for the on-going development projects under the Institute (Table 2). Out of total ADP allocation of Tk. 9633.69 lakh. The GoB funding was Tk. 9616.00 lakh, which was offered by different aid-giving agencies as Project Aid (PA)

Besides, an amount Tk. 28922.11 lakh was made available from the revenue budget to meet the recurring expenditure of the already complied projects of the Institute (Table)

Table-1: Budget provision of BARI for 2016-2017 (in lakh Tk.)

Total	GOB Head			Project Aid (PA/RPA	Capital Head	Revenue Head		Total
	ADP	Revenue	Total			ADP	Revenue	
38555.80	9616.00	28922.11	38538.11	17.69	3686.00	5937.42	28922.11	34859.53

Table-2: Development Budget (Annual Development Programme) of BARI for 2016-2017 (in lakh Tk.)

No.	Name of Projects	Total	GOB	PA	Capital	Revenue		Total
						Pay & Allow.	Contingency	
	Development Projects							
1.	Enhancing Quality Seed Supply	10.96	5.00	5.96	0	3.90	5.60	9.50
2.	Mujibnagar Integrated Agricultural Development Project	125.00	125.00	0	0	15.63	109.37	125.00
3.	Integrated Agricultural Productivity Project (BARI Part)	11.73	0	11.73	0	6.45	0	6.45
4.	Development and expansion of research and resaearch infrastructure of BARI	6180.00	6180.00	0	2533.00	0	3647.00	3647.00
5.	Pirojpur-Gopalgonj-Bagherhat Integrated Agrivultural Development Project (BARI Part)	300.00	300.00	0	0	8.31	291.69	300.00
6.	Cytrus Development Project (BARI Part)	274.00	274.00	0	64.00	39.75	170.25	210.00

No.	Name of Projects	Total	GOB	PA	Capital	Revenue		Total
						Pay & Allow.	Contingency	
7.	Improvement and Quality Seed Production of Wheat and Maize-2nd Phase	790.00	790.00	0	500.00	0	290.00	290.00
8.	Strengthening of Oilseed and Pulses Research and Development in Bangladesh	734.00	734.00	0	322.00	10.48	400.00	410.48
9.	Strengthening Research on Horticultural Crops and Dissemination of Horticultural & Field Crop Technology at Charland Areas	1208.00	1208.00	0	267.00	0	938.99	938.99
	Total :	**9633.69**	**9616.00**	**17.69**	**3686.00**	**84.52**	**5852.90**	**5937.42**

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INFORMATION REPORT

(As per Information Commission Requirements)

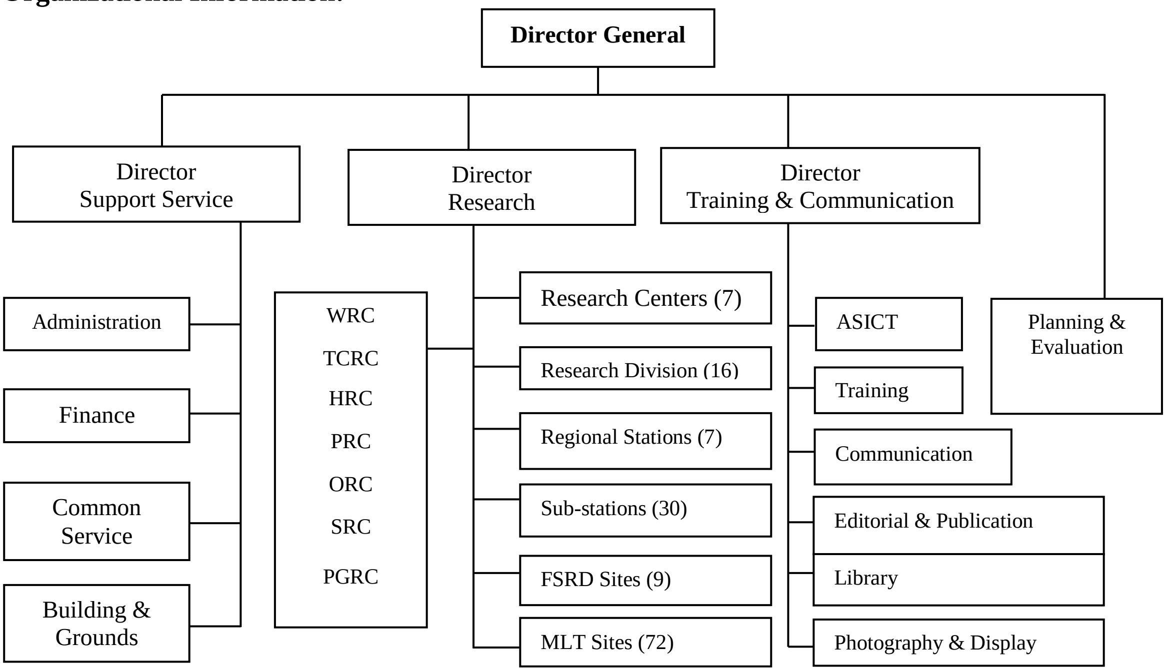
Institutional information:

BARI (Bangladesh Agricultural research Institute) is the largest multi-crop research institute conducting research on a wide variety of crops such as cereals, tubers, pulses, oilseeds, vegetables, fruits, spices, flowers, etc. Besides variety development, this institute carries out research on such areas as soil and crop management, disease and insect management, water management and irrigation, development of farm machinery, improvement of cropping and farming system management, post-harvest handling and processing, and socio-economic studies related to production, processing, marketing and consumption. The institute functions with the Director General as the chief executive along with three directors of its three major wings such as Research Wing, Support Service Wing and Training & Communication Wing. The research Wing executes and monitors all the research programs and other research activities through 7 special crop research centers, 17 research divisions, 7 regional agricultural research stations and 30 sub-stations. Support Service Wing provides all the logistics support for research and personnel management. This wing is also responsible for infrastructural development and general procurement of the institute. The Training & Communication Wing is responsible for human resource development through conducting short term, mid tram as well as long term training and arranging scholarships for higher studies. Dissemination of information through print and electronic media, organizing seminars and symposia are also the important areas of activities of this wing.

BARI has a long historical background of its own. The emergence of the Institute in its present status has occurred through a number of changes starting from simply a sub-ordinate status under the Department of Land Records in the then Bengal. On the recommendation of the famine commission in 1880, the Bengal Department of Agriculture was established as a sub-ordinate part of the Department of Land Records in the then Bengal. In 1906, Lord Curzon, the then Vice Roy of India had granted separate status to the Bengal Department of Agriculture and in the same year, a Nuclear Agriculture Research Laboratory under this department was established at Tajgaon, Dhaka In 1908, an experimental station what has become known as Dhaka Farm was established on an area of 161.20 hectares of land. This Dhaka Farm was the predecessor of BARI and some other research institutes. Establishment of Dhaka Farm offered a good scope for conducting research in the field level in 1947, Bengal Department of Agriculture was renamed as East Pakistan Department of Agricultural. The two constituent divisions of the department were Research and Extension. In 1962, there was a severe blow to agriculture research when the land of Dhaka Farm was acquired for establishing Second Capital (today called Sher-e-Bangla Nagar). In 1968 two separate directorates were established – one was Directorate of Agriculture (Extension and Management) and the other was Directorate of Agriculture (Research and Education). The Directorate of Agriculture (Research and Education) was mostly concerned with research. This directorate was also responsible for the management of Bangladesh Agriculture Institute (BAI) at Sher-e-Bangla Nagar, Dhaka. Later in 1980s and 1990s, two other agriculture colleges, one in Patuakhali and the other in Dinajpur, were established. These two agriculture colleges were also administered by BARI until these became universities In 1971, the former provincial organization took on national responsibilities. Like many other sectors, agricultural sector inherited poor manpower and insufficient administrative set ups as well. Therefore, it was rightly thought to have established a coordinated and comprehensive research and some major decisions were taken up in 1973. Another important development in the year was the presidential

Order No. XXXII that helps strengthen and reconstitute agricultural research organizations and system in the country. Upon subsequent developments of research institutions led to further restructuring In 1976, through the presidential Order No. LXII, the Bangladesh Agricultural Research Institute (BARI) emerged as an autonomous and effective research organization following the dissolution of the Directorate of Agriculture (Research and Education) with sufficient operational flexibility, structural modification and improvement of regional and sub-stations.

Organizational Information:



Operational information:

Director General who is the Chief Executive of the institute has overall responsibility for administration, finance, development and execution of program related to research, manpower development, dissemination of information, transfer of technology and other extension activities. The Director General is assisted by three directors: Director (Research), Director (Support Service), and Director (Training & Communication).

Director (Research) is responsible for program planning, monitoring and evaluation of the research activities as performed by the research centers, divisions and the regional and sub-stations.

Personal management, finance & accounts, procurement, infrastructure development, security, transportation and repair & maintenance are the major responsibilities of Director (Support Service)

Director (Training & Communication), on the other hand, is responsible for the transfer of technologies to the users through trainings, seminars, workshop, print & electronic media. Human resource development through training and arrangement scholarships for higher studies at home and aboard also fall within his responsibilities.

Each research division is headed by a Chief Scientific Officer (CSO) who is also designated as divisional head whereas a research center is headed by a Director/Project Director. Each divisional head is assisted by the concerned scientist starting from Scientific Officer (SO) to Principal Scientific Officer (PSO). On the other head, each research center is comprised of scientists from various disciplines in the rank of Scientific Officer (SO) to Chief Scientific Officer (CSO).

Regional Stations are headed by senior scientist equivalent to the status of CSO, while the sub-stations are headed by the scientists in the rank of either PSO or SSO.

Information on Right to Information: RTI of BARI

Designated Officer	
Officer’s name	**:** Dr. Md. Saiful Islam ড. মো: সাইফুল ইসলাম
Designation	: Principal Scientific Officer (PSO)
Phone	: 4 9270026
Mobile	: 01552-388731
Email	: saiful@bari.gov.bd
Website	: www.bari.gov.bd
Office	: ASICT Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

Designated Officer (Alternative)	
Officer’s name	: Md. Mizanur Rahman Khandaker মো: মিজানুর রহমান খন্দকার
Designation	: Deputy Director (Admin)
Phone	: 49270010
Mobile	: 01552-385116
Email	: mizanur73@yahoo.com
Website	: www.bari.gov.bd
Office	: Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

Designated Officer (Appeal)	
Officer’s name	: Dr. Abul Kalam Azad ড. আবুল কালাম আযাদ
Designation	: Director General
Phone	: 49263540
Mobile	: 01714-179048
Email	: dg.bari@bari.gov.bd
Website	: www.bari.gov.bd
Office	: Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

List of Information delivery to the citizen during 2016

তথ্য অধিকার আইন, ২০০৯ এর ফরমেট অনুযায়ী তথ্য সরবরাহের জন্য প্রাপ্ত আবেদনের সংখ্যা	তথ্য সরবরাহের মাধ্যমে নিষ্পত্তিকৃত আবেদনের সংখ্যা	অনুরোধকৃত তথ্য না দেয়ার সিদ্ধান্তের সংখ্যা ও উক্ত সিদ্ধান্ত গ্রহণের কারণ	দায়িত্বপ্রাপ্ত কর্মকর্তার সিদ্ধান্তের বিরুদ্ধে আপীলের সংখ্যা	আপীল নিষ্পত্তির সংখ্যা	কর্তৃপক্ষ কর্তৃক দায়িত্বপ্রাপ্ত কর্মকর্তার বিরুদ্ধে গৃহীত শাস্তিমূলক ব্যবস্থার সংখ্যা	তথ্য অধিকার (তথ্য প্রাপ্তি সংক্রান্ত) বিধিমালা ২০০৯ এর বিধি ৮ অনুযায়ী তথ্যের মূল্য বাবদ আদায়কৃত অর্থের পরিমাণ	কর্তৃপক্ষ কর্তৃক গৃহীত বিভিন্ন কার্যক্রমের বিবরণ	মন্তব্য
১	২	৩	৪	৫	৬	৭	৮	৯
২৪০ *১টি (তথ্য কমিশনের ফরমেট অনুযায়ী) *২৩৯টি (বিএআরআই এর ওয়েব পোর্টাল ও মোবাইল অ্যাপস হতে প্রাপ্ত ই-কৃষি সংক্রান্ত তথ্যের প্রশ্ন সংখ্যা)	২৪০ *১টি (তথ্য কমিশনকে জানানো হয়েছে) *২৩৯টি (বিএআরআই এর ওয়েব পোর্টাল ও মোবাইল অ্যাপস হতে প্রাপ্ত ই- কৃষি সংক্রান্ত তথ্যের উত্তর সংখ্যা)	-	-	-	-	-	-	

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