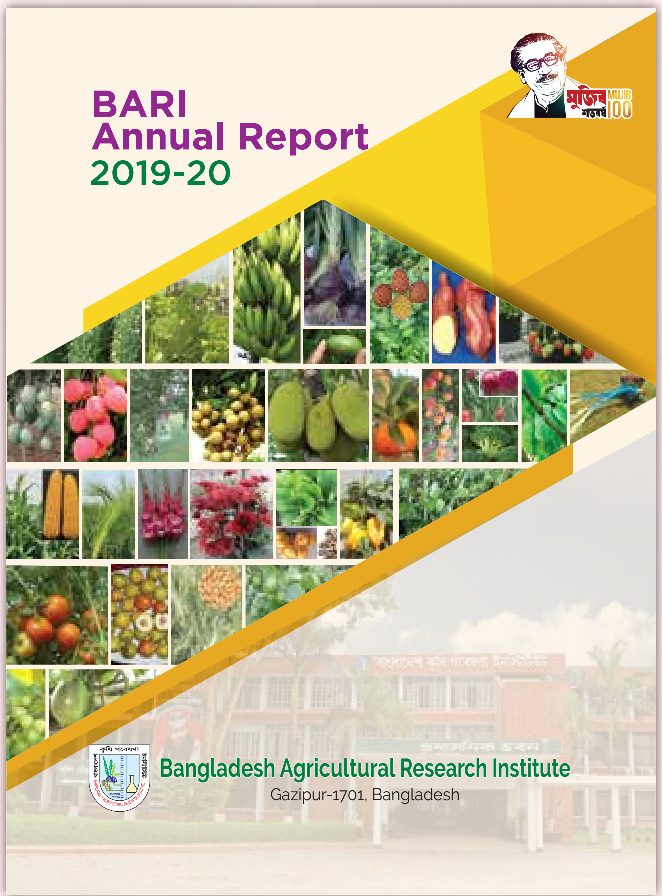
BARI Annual Report 2019-20

Bangladesh Agricultural Research Institute

Gazipur-1701, Bangladesh



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Foreword

The annual report is an in-depth, comprehensive overview of the achievements and activities of an organization from the preceding year. It is produced on a yearly basis and informed all about the overall performance, achievements and vision for the future. So, this annual report includes the major findings of the experiments conducted by the scientists of different Crop Research Centers and Research Divisions of BARI during the year 2019-20. The major research areas include variety development of different crops, such as 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), spices (onion, garlic, chili, turmeric, ginger, fenugreek, etc.) and cereals (millet, barley, sorghum, etc.).

The area of research also includes improvement of cropping systems, crop, soil, water and irrigation management, plant nutrition, disease and insect management, production economics, development of low-cost farm machineries, postharvest processing, and farm management. Besides, attention was focused on adaptation and mitigation of climate change, plant biotechnological research, improvement of floriculture, and hill farming. Our scientists have also engaged in developing technologies which are appropriate as well as sustainable with a view to narrowing the ongoing gap between current food demand and its production in the country.

The annual report summarizes all the research activities of this year. But it is really very hard to accommodate all the findings of all the studies in such a single volume. So like previous years, only the major findings of the studies have been incorporated in this report. The readers can get information about 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 express my heartfelt thanks and appreciate the scientists, editors, and associates who have worked hard to bring this report out. I hope this report will be very useful to scientists, teachers, students, policymakers and other stakeholders who have engaged in agricultural research and development for food and nutrition security.

Dr. Md. Nazirul Islam
Director General, BARI


Bangladesh Map
Central Station
Regional Station
Research Centre
Sub Station
SP. Crop Station
North
INDIA
INDIA
INDIA
MYANMAR
B A Y O F B E N G A L
PANCHAGARH
THAKURGAON
NILPHAMARI
LALMONIRHAT
DEBGANJ
BURIRHAT
NASHIPUR
KURIGRAM
DINAJPUR
RANGPUR
MAHIGANJ
GAIBANDHA
JOYPURHAT
NAOGAON
SHIBGANJ
BOGRA
SHERPUR
JAMALPUR
SUNAMGANJ
SYLHET
NETRAKONA
MYMENSINGH
HABIGANJ
MOULVIBAZAR
AKBARPUR
NAWAB GANJ
KAZLA
RAJSHAHI
NATOR
ISHURDI
SIRAJGANJ
TANGAIL
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MANIKGANJ
DHAKA
N'GANJ
BRAHMANBARIA
CHUADANGA
RAJBARI
JHENAIDAH
MAGURA
FARIDPUR
MUNSHIGANJ
COMILLA
KHAGRACHARI (HILL TRACTS)
SARIATPUR
CHANDPUR
JESSORE
NARAIL
MADARIPUR
GOPALGANJ
BARISAL
LAXMIPUR
NOAKHALI
FENI
HATHAZARI
RANGAMATI (HILL TRACTS)
PAHARTALI
RAIKHALI
KHULNA
PEROJPUR
RAHAMATPUR
JHALAKATI
BAGERHAT
PATUAKHALI
BHOLA
CHITTAGONG
BARGUNA
BANDARBAN (HILL TRACTS)
COXS BAZAR
0 10 20 30 40 50 miles
0 20 40 60 80 km

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- A representative of the Council (nominated by the Council)
- The Directors of the Institute (Ex-officio)
- Two senior scientists of the Institute (nominated by the Ministry or the Division dealing with agriculture)
- A representative of the DAE not below the rank of Director (nominated by the Ministry)
- Two representatives, one from the Ministry or the Division dealing with agriculture and the other from the Finance Division not below the rank of Deputy Secretary (nominated by the respective Ministry or Division)
- 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.

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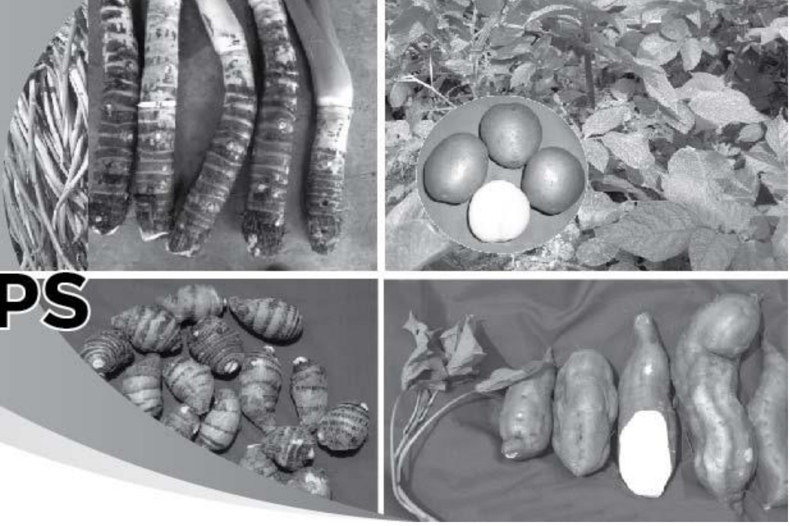
01 TUBER CROPS



Tuber Crops Research Centre (TCRC), BARI deals with Potato, Sweet Potato, Aroids, Cassava and other minor tuber crops. Breeding, biotechnology, disease & pest management, soil & nutrient management, organic culture, postharvest processing are the major concern of TCRC. Major achievements during 2019-2020 on varietal improvement, biotechnology approaches, disease management, insect management, production technology, soil, water and nutrient management, postharvest technology, organic culture and technology transfer activities are reported:

Varietal Improvement

Potato

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. But its varietal improvement has only been limited to introduction and selection until the year 2000 due to lack of facility. Potato plants usually do not initiate flower under the short day conditions of Bangladesh. In the recent years, hybridization has been made possible at 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 194 and 190 genotypes/ varieties, respectively under 16 hours extended photoperiod to create variability, and for the selection of desirable genotypes. At Joydebpur, 205 out of 571 crosses and at Debigonj, 709 out of 2309 crosses produced berries. In total 255g hybrid seeds were produced of which 200 g was at Debigonj and rest at Joydebpur.

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

Hybrid seeds which were produced in 2018-19 at Gazipur and Debiganj were sowed at Breeder Seed Production Centre, Debiganj. Around 874 crosses were grouped into three. 1st priority group includes 250 crosses and 2nd priority group comprises 164 crosses and third priority group includes 386 crosses based on origin and preferable character. From 1st and 2nd Priority group, 414 cross were sowed in to tray and 400 crosses were germinated. Crosses of third group were sowed following broadcasting method and covered with straw. Out of 460, only 192 crosses were planted, single plants of 117 crosses were selected from total population. Considering the performance, all groups were harvested selected plants and tubers weighing 200 kg was stored for the next year observation.

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

For selection study planted potato clones were 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 51 potato clones weighing 1429 kg were selected and stored at BSPC, Debiganj during 2019-20 for further evaluation.

Preliminary yield trial with clonal potato hybrids

Eleven hybrid clones of potato were evaluated along with four check varieties BARI Alu-7

(Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady-Rosetta) at Debigonj and Gazipur. Trial results of Gazipur location were not satisfactory due to unavoidable circumstances. However at Debigonj, most of the genotypes of hybrid clones gave higher yield over the check varieties. The highest yield (57 t/ha) was obtained from the clone 16.9 where as the lowest yield (34.49 t /ha) was found from the genotype 16.28. In case of dry matter, the clones 16.16 (19.11%) and 16.34 (18.65%) are suitable for processing purpose. No early mature clone was found. Most of the genotypes produced higher yields over the check varieties for that all the hybrid clones can be selected for the next year trial.

Secondary yield trial with clonal potato hybrids

Eight hybrid clones of potato were evaluated along with four check varieties BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) at Debigonj, Gazipur and Jamalpur. Combined analysis was done to see the genotype and location interactions. The significant influence was observed for different environmental factors of different locations on the expression of different characters of potato. No early bulker clone was selected from this study. No early mature clone was found than checks BARI Alu-13 (Granola) and BARI Alu-28 (Lady Rosetta). The highest average marketable yield (47.05 t/ha) was observed in clone 15.156 followed by clones 15.126 (44.93 t/ha) and 15.139 (44.82 t/ha). Clones 15.126, 15.139 and 15.156 may be selected for AYT due to their higher tuber yield potentialities. In case of dry matter, check variety BARI Alu-28 (Lady Rosetta) gave highest result but average dry matter percentage of clones15.92 (20.98), 15.112 (20.52) and 15.156 (20.88) were also satisfactory, which is suitable for processing purpose. Clone 15.92 gave higher percentage (73.65) of larger sized tuber which is important for processing and export purpose. Clones 15.92, 15.126 and 15.156 performed better than checks regarding taste, appearance and texture of boiled potato. Considering the marketable tuber yield, dry matter, organoleptic taste, disease, insect infestation and tuber characteristics (shape, size, colour, scoring) these five clones (15.92, 15.112, 15.126, 15.139 and 15.156) may be selected for next year AYT.

Advanced yield trial of clonal potato hybrids

Five clonal hybrids of potato were evaluated with three check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady-Rosetta) at six locations during 2019-20 for seventh generation. Tuber yield at 65 DAP was recorded to identify the early bulker genotypes. No early bulker clone was selected from this study. No early mature clone was found than checks BARI Alu-13 (Granola). At final harvest, Clone 14.11, 14.10 and 14.44 can be selected for RYT due to their higher tuber yield potential (43.23 t/ha), (40.59 t/ha) and (39.30 t/ha), respectively. In case of dry matter, check variety BARI Alu-28 (Lady Rosetta) gave the highest result but average dry matter percentage of clone 14.11 (20.04) was also satisfactory, which is suitable for processing purpose. Clone 14.10 gave higher percentage (68.42) of larger sized tuber which is important for processing and export purpose. Clone 14.44 performed the best regarding taste, appearance and texture of boiled potato. Clones 14.10, 14.11 and 14.44 can be selected for next year RYT due to their performance regarding tuber yield, dry matter, organoleptic taste performance, disease and insect infestation and tuber characteristics (shape, size, colour, scoring) etc.

Participatory variety selection of advanced clonal hybrids

Five clonal hybrids with three checks varieties were evaluated at farmer's field under participatory variety selection to understand the performance as well as farmers opinion. In case of average yield of all locations the highest yield (39.14 t/ha) was recorded in 14.11 followed by 14.44 (38.72 t/ha) and the lowest average yield was found in check variety BARI Alu-13 (Granola) (33.45 t/ha). Considering tuber yield, tuber size, shape and colour, farmers of all locations showed their keen interest to all the clones, but varied from location to location. Therefore, further evaluation is needed for confirmation.

Regional yield trial of clonal hybrids of potato

Three clonal hybrids of potato namely 13.7, 13.17 and 13.19 along with three check varieties BARI Alu-7 (Diamant), BARI Alu-25 (Asterix) and BARI Alu-28 (Lady Rosetta) were evaluated at six agro-ecological locations during 2019-20 cropping season in RYT. No early bulker clone was selected from this study. No early mature clone was found than check variety BARI Alu-28 (Lady Rosetta). The highest average yield was found in clone 13.7 (42.81 t/ha) followed by clone 13.19 (42.07 t/ha). These two clones may be recommended for release as commercial varieties due to their higher tuber yield potentialities. Average dry matter percentages of tested clones were not suitable for processing purpose. Clone 13.19 gave higher percentage (70.86 %) of larger sized tuber which is important for export purpose. In case of organoleptic taste, the clones 13.7 and 13.19 performed better regarding taste, appearance and texture of boiled potato. Considering tuber yield, organoleptic taste performance, disease, insect infestation and tuber characteristics (shape, size, colour, scoring) these two clones (13.7 and 13.19) may be recommended for release as commercial varieties.

Table 1.Tuber yield at 95 DAP of selected genotypes under RYT during 2019-20

Variety\location	Bogura	Debiganj	Gazipur	Jamalpur	Jashore	Munshiganj	Mean
13.7	49.40 c	40.65 i	29.46 qr	52.32 b	54.17 a	30.86 pq	42.81 a
13.17	47.59 ef	36.11 kl	35.20 lm	40.09 ij	49.26 cd	27.68 st	39.32 c
13.19	45.67 gh	39.07ij	31.44 op	50.33 c	48.98cde	36.94 k	42.07 b
BARI Alu-7 (Diamant)	44.84 h	32.53 no	31.48 op	39.33 ij	47.80 def	27.43 st	37.24 d
BARI Alu-25 (Asterix)	47.15 fg	33.96 mn	24.35 u	44.93 h	38.70 j	28.95 rs	36.34 e
BARI Alu-28 (L. Rosetta)	38.93 j	30.89 pq	21.53 v	36.54 kl	35.68 kl	26.21 t	31.63 f
CV%				2.56			

Participatory variety selection of clonal hybrids

Three clonal hybrids with check varieties were evaluated at farmer's fields under participatory variety selection to understand the performance as well as farmers opinion. The highest average tuber yield (41.44 t/ha) was recorded in 13.19 followed by 13.7 (35.99 t/ha) and lowest average yield was found in 13.17 (28.88 t/ha). Farmers were very much interested in the clonal hybrids 13.7 and 13.19 for their yield, tuber size, shape, color but varied location to location. Therefore, these two clones may be recommended for the release as commercial varieties.

Table 2. Performance of clonal hybrids of potato for tuber yield under PVS at 95 DAP in farmers' fields during 2019-20

Variety/Hybrid clone	Tuber Yield (t/ha) at 95 DAP						
	Bogura	Debigonj	Gazipur	Jamalpur	Jashore	Munshiganj	Mean
13.7	38.29	25.89	33.34	31.34	43.97	43.09	35.99
13.17	38.85	24.25	22.78	26.52	34.4	26.45	28.88
13.19	48.86	-	31.52	48.09	38.94	39.79	41.44
BARI Alu-7 (Diamant)	45.08	21.48	25.31	31.66	33.94	39.68	32.86
BARI Alu-25 (Asterix)	43.09	28.84	27.78	28.98	34.12	39.81	33.77
BARI Alu-28 (L.Rosetta)	38.30	-	31.52	39.87	29.21	33.46	34.47

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

Six 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 of Bangladesh (Bogura, Debiganj, Gazipur, Jamalpur, Jashore and Munshigonj) during 2019-20 for second generation trial. The significant influence was observed for different environmental factors of varied locations on the expression of different characters of potato. The highest yield at 65 Days After Planting (DAP) was found (44.57 t/ha) with Alcander at Gazipur. But Delia Red produced the best average yield (27.88 t/ha) over the six locations which was statistically similar with the average yield of Alcander (25.87 t/ha), Twister (27.00) and Prada (25.98). Exotic variety Delia Red gave the highest yield (71.08 t/ha) at Gazipur. The highest average yield (48.15 t/ha) was found in Diverse Zailengence which was statistically similar with BARI Alu-7 (45.88), Twister (45.70), Delia Red (41.68), and Prada (41.43). At harvest, the average number of tuber/hill (10.62) was found in BARI Alu-25 (Asterix) followed by Twinner (10.58) over the locations. On the other hand, the average lowest number of tuber/hill (8.24) was found with Prada. In case of tuber weight/hill, the statistically average highest tuber weight/hill was found in Diverse Zailengence (0.721 Kg/hill) while the statistically lowest weight of tuber/hill (0.499 kg/hill) was found with BARI Alu-28 (Lady Rosetta) over the locations. Finally Exotic varieties Diverse Zailengence, Twister, Delia Red and Prada can be selected for AYT on the basis of field performance in 2019-20.

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

Ten 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 (Bogura, Debiganj, Gazipur, Jamalpur, Jashore and Munshigonj) of Bangladesh during 2019-20 for third generation trial. The significant influence was observed for different environmental factors of different locations on the expression of different characters of potato. The highest tuber yield at 65 DAP was found (41.44 t/ha) with Fontane at Bogura and Debiganj. But, HZD 1245 performed the best and produced average yield (34.54 t/ha) over the six locations which was statistically similar with the average yield Innovator and Ottawa (32.02 t/ha). HZD 1249, Ottawa and Innovator are good for early bulker. Exotic variety Ottawa gave the highest yield (71.28t/ha) at Munshigonj. The highest average yield (55.17 t/ha) was also found in Ottawa. At harvest, the average number of tuber/hill (17.10) was found in BARI Alu-25 (Asterix) over the locations. The average lowest number of tuber/hill (10.21) was found with Alberta. In case of tuber weight/hill, the statistically average highest tuber weight/hill was found in Arizona while the statistically the lowest weight of tuber/hill (0.601 kg) was found with Fontane over the locations. Dry matter percentage at harvest was highest with check variety Alberta (24.43) at Gazipur. Alberta gave the statistically highest percentage of dry matter (21.26) over the location. In the both cases of tuber grade by number (%) and weight (%), most of the exotic lines produced desired number of medium size tubers (28-40 cm and 40-55-mm size) at all the locations. Seed tuber grade performance was satisfactory among the genotypes and over the locations. Finally, Exotic variety Ottawa, Arizona, Al Russet, Innovator and HZD 1249 may be selected for RYT on the basis of field performance in the year of 2019-20.

Participatory variety selection of advanced exotic potato varieties for table, export and processing purposes

Ten exotic potato varieties with four check varieties were evaluated at farmers' field of six different agro ecological zones during 2019-20 cropping season in PVS. Yield of ten tested new exotic varieties varied significantly from location to location. In some cases more than double yield was obtained. Farmers perception also varied. For that reason the tested varieties need to be further evaluated for confirmation.

Regional yield trial with exotic potato varieties

Three exotic potato varieties namely Messi, Picobella and Sun Red 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 zones during 2019-20 cropping season in RYT. The significant influence was observed in different environmental factors in different locations on the expression at different characters of potato. No early bulker clone was selected from this study. No early mature clone was found than check variety BARI Alu-28 (Lady Rosetta). The highest average yield was found in in Messi (42.81 t/ha) followed by Sun Red (39.21 t/ha) and Picobella (38.62 t/ha). Therefore, these three exotic varieties may be recommended for the release as commercial varieties due to their higher tuber yield potentialities. Average dry matter percentages of tested exotic varieties were not suitable for processing purpose. Sun Red (67.13%), Messi (65.33%) and Picobella (65.21%) gave higher percentages of larger sized tuber which is important for export purpose. In case of organoleptic taste, Picobella performed best regarding taste, appearance and texture of boiled potato. Considering tuber yield, organoleptic taste performance, disease, insect infestation and tuber characteristics (shape, size, colour, scoring) these three exotic varieties (Messi, Picobella and Sun Red) can be recommended for release as commercial varieties.

Table 3.Tuber yield at 95 DAP of selected genotypes of potato under RYT during 2019-20

Variety\location	Bogura	Debiganj	Gazipur	Jamalpur	Jashore	Munshiganj	Mean
Picobella	51.92 a	39.12fg	25.98 no	39.54fg	41.02 f	34.13ij	38.62 b
Messi	47.08 c	35.35 hi	31.06 k	44.39 e	46.64 cd	34.06ij	39.76 a
Sun Red	44.86 de	34.97 hi	31.39 k	39.03fg	49.15 b	35.87 hi	39.21ab
BARI Alu-7 (Diamant)	44.84 de	32.53jk	31.48 k	39.33fg	47.80bc	27.43mn	37.24 c
BARI Alu-25 (Asterix)	47.15bc	33.96ij	24.35 o	44.93 de	38.70 g	28.95 lm	36.34 d
BARI Alu-28 (L. Rosetta)	38.93 g	30.89 kl	21.53 p	36.54 h	35.68 hi	26.21 no	31.63 e
CV%	3.40						

Participatory variety selection of exotic potato varieties

Three exotic potato varieties along with three check varieties were evaluated at farmers' field of five different agro ecological environments/locations during 2019-20 cropping season in PVS. Yield of three tested new exotic varieties varied significantly from location to location. The average highest tuber yield (37.13 t/ha) was recorded in Messi followed by Picobella (36.63 t/ha) and the lowest average yield was found in check variety BARI Alu-28 (Lady Rosetta) (34.47 t/ha). Farmers were very much interested in these exotic varieties but varied location to location. Therefore, these varieties may be recommended for the release as commercial varieties.

Table 4. Performance of exotic potato varieties for tuber yield under PVS at 95 DAP in farmers' fields during 2019-20

Genotypes	Tuber Yield (t/ha) at 95 DAP						
	Bogura	Debigonj	Gazipur	Jamalpur	Jashore	Munshiganj	Mean
Messi	34.14	-	37.03	36.05	34.72	43.72	37.13
Picobella	52.21	-	28.89	26.96	44.09	31.00	36.63
Sun Red	37.40	-	30.46	30.70	34.97	38.97	34.50
BARI Alu-7 (Diamant)	45.08	-	25.31	31.66	33.94	39.68	35.13
BARI Alu-25 (Asterix)	43.09	-	27.78	28.98	34.12	39.81	35.13
BARI Alu-28 (L. Rosetta)	38.30	-	31.52	39.87	29.21	33.46	34.47

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

Potato production outside the regular growing season resulted in farmers profit. In addition, potato consumers are attracted due to decreased supply in the market. Further, farmers grew an early potato in the northern regions of Bangladesh and gained more profit due to higher price at that time. However, potato production may affect by increase pest and disease pressure and higher soil temperature. We hypothesized that potato varieties showed less significant tuber yield reduction when they are not grown in a normal season. This experiment was taken to find out suitable genotypes for earlier cultivation in northern regions of Bangladesh prior to mid of November. Two four potato varieties were evaluated at the breeder seed production center, Debiganj, Panchagarh for four growing period i.e very early, early, normal and late growing season during 2019-2020 following a randomized complete block design with three replications. Results revealed significant variations due to genotypes for all characters in four sowing conditions. Germination percent, plant height, stem per hill, marketable tuber yield at 65 days, marketable tuber yield at 90 days, non-marketable yield at 65 days, non-marketable yield at 95 days were recorded. The relative position of different varieties on the biplots is based on its projection on to the XY-axis in AMMI Biplot. Considering yield and yield contributing characters Clone 13.17, BARI Alu 7 and Arizona outperformed in all growing condition with wider adaptability and stability regarding tuber yield.

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 glut in the market. So, they get discouraged in potato cultivation, which can’t be entertained in a food nutrition deficit country like Bangladesh. Therefore, we need to export this surplus potato to the foreign countries. 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 are 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-three released potato varieties and one exotic material were evaluated at seven different agro ecological zones during 2019-20 cropping season for selecting export suitability of the variety. Tuber yield and grading by percent number and weight reveled that the tested varieties varied significantly between the locations and within location. Post-harvest data collection is not yet been completed, which is one of the most important criteria for selecting exportable potato variety. This is the three-year trial; minimum three years data needed to select suitable variety (s) for export.

Multiplication of bio fortified CIP Ggermplasm

Potato is the third most important food crop in Bangladesh. In our country, about 9.65 million tons of potato were produced from about 0.468 million hectares of land with an average yield of 20.61 t ha-1 (BBS, 2019). Due to the development of suitable variety as well as different production package and also regular supply of inputs potato production increases day by day. 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. To fulfill SDG goals we need to ensure food as well as nutritional security. Biofortification is a feasible and cost-effective means of delivering micronutrients to populations that may have limited access to diverse diets and other micronutrient interventions (H.E. Bouis, A. Saltzman, 2017). The ultimate goal of bio fortification is producing nutritious and safe foods, sufficiently and sustainability. Micronutrient malnutrition is one of the major problems in many developing countries like Bangladesh. This study was under taken by TCRC in collaboration with the CIP to reduce malnutrition of Bangladeshi people through the use of bio fortified potatoes. Forty bio fortified and ten late blight tolerant germplasm were collected from the CIP, Peru. Total 7893 plantlet received from TCRC tissue culture lab of 50 germplasm produced 360.1 kg minituber at BSPC Debigonj. A total 188.25 kg G_1 tuber obtained from planted minituber received from TCRC, which was produced off season under greenhouse condition in pot and aeroponic system. Collected germplasm also maintained in TCRC tissue culture lab for further multiplication.

Morphological characterization of advanced breeding lines and exotic potato varieties

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 to the objective of the study was collect information on genetic divergence in the newly acquired genotypes so that useful parental materials for the breeding program could be selected. Eight advanced clones of potato developed from own crossiong program of TCRC and thirteen exotic varieties were characterized at TCRC, Gazipur during 2019-20 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 lots of variations in morphological characteristics in addition agro-morphic characters. Large variation was found among the genotypes and distinct characters were recorded which could help to find out the respective clones as well. Furthermore, lot of information were identified which could provide important information to the breeders.

Development of diploid potato inbred line

Diploid potato germplasms as TPS was introduced from Michigan State University 2017-18 and planted in BSPC to get tubers. High yield tuber producing line was selected to plant in our crossing block both at BSPC, Debigonj and TCRC, Joydebpur. Selected diploid lines were planted at TCRC and BSPC. Total planted genotypes were 14 in TCRC and 22 in BSPC. Most of them did not flowered at all in both locations. Some of them even produced flowers but there was no viable pollen to self them. Rest of them produced pollen and selfed but did not set berry. Some diploid flowered genotypes were found self-compatible genotypes from TCRC and BSPC, respectively. Only B-10 genotypes gave 65 TPS which will be used for next generation of selfing.

Production of seedling tubers of the selfed populations (F_1S_0)

Selected diploid lines were planted at TCRC and BSPC in 2018-19. Total planted genotypes were 10 in TCRC and 22 in BSPC. Most of them did not flowered at all in both locations. Some of them even produced flowers but there was no viable pollen to self them. Some diploid flowered genotypes were found self-compatible genotypes from TCRC and BSPC, respectively. Only B-25 genotypes gave 15 TPS and used for generating selfed population. From them 50 planlets were produced from one TPS generation which will be planted next year to observe their performances.

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

Any variety, line, genotypes and land raceses considerd as germplasm which are very impotant 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 important for conservation as well as preservation of gene pool for 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. The same experiment was also conducted in this year (2019-2020) for this same purpose. A total of 20860 kg seeds of potato was preserved in Breeder Seed Production Center cold storage, Debiganj, Panchagarh collected from 1278 potato variety/germplasm/hybrid clone during 2019-2020. The preserved materials will be used in future for variety development program.

Multipliation, purification and maintenance of indigenous potato varieties

Indigenous potato variety (IPV) contains 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 normal 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 be checked with view to how much increase in yield compared to previous year. These were the objectives for this trial. During 2019-20 cropping year, quality seeds of nine indigenous variety viz. Ausha, Challisha, Dohazari, Indurkani, Lalpakri, Patnai, Sadaguti, Shilbilati and Sindurkota were produced under net house condition. As such as 247 kg seeds were preserved in cold-storage of BSPC, Debiganj, Panchagarh for the next year use.

Sweet Potato

Hybridization of sweet potato by polycrossing

In order to exploit heterozygosity among sweet potato genotypes polycross method was used to generate half-sib sweet potato hybrid seeds with great variability regarding yield potentiality, dry flesh, earliness, carotene content, disease tolerance & palatability. The experiment was conducted during 2019-20 at Gazipur A total of 112 numbers of F_1 seeds were collected from ten parents. The highest number of F_1 seeds was collected from BARI SP-12 (37) followed by BARI SP-2 (29) and the lowest number of F_1 seeds from BARI SP-4 (21). These F_1 seeds will be sown in nursery bed next season for vine as well as tuber production and evaluation.

Secondary yield trial of CIP (Mozambique) clones of sweet potato

A total of 11 genotypes (Moz 1.15, Moz 1.39, Moz 1.8, Moz 1.9, Moz 5.2, Moz6.3, Moz8.3, Moz8.5, Moz19.1, Moz21.3 and Moz21.6) derived from CIP were evaluated regarding their phenotypic characters, yield and yield contributing characters. There was huge diversity present among these lines. Especially wide variation present in yield which varied from 21.06 t/ha to 0.00 t/ha and flesh color from deep orange to purple shade. The information might be useful for the optimal design of plant breeding programs, influencing the choice of genotypes to cross for the development of new populations or for direct selection. Considering all the characters those were studied under this experiment two (2) germplasm namely Moz1.15 and Moz 1.9 germplasm were selected.

Secondary yield trial with CIP clones of sweet potato

Six (6) sweet potato genotypes (CIP-106082.1, CIP-189151.8, CIP-194281.2, CIP-199062.1, CIP-400039 and CIP-440004) with contrasting beta carotene and mineral content those were provided by International Potato Centre (CIP) were evaluated at Gazipur in order to get a variety contrasting with marketable higher yield, length of main vine, root length, no.of roots/plant, weight of roots/plant& weevil resistance. Considering these criteria, only one (CIP400039) genotype was selected for the next year trial.

Advanced yield trial with F_1C_6 hybrid clone of sweet potato

A field trial was done to evaluate two (02) hybrid clones ($H_{9.7}$/12 and $H_{9.10}$/12) of sweet potato at five locations during 2019-20 cropping season along with BARI SP-4 and BARI SP-8 used as check. Two tested clone hybrids were again selected for further trial based on marketable yield, dry matter content, carotene content, earliness and overall acceptability score.

Regional yield trial with anthocyanin containing sweet potato

Considering all the qualitative and quantitative characters it can be assumed that this newly introduced Anthon 1 would be the promising one specially as a bio fortified crop. This promising line will be applied for releasing as a variety this next year.

Regional yield trial with white fleshed sweet potato

Two white fleshed local cultivars (WF001 and WF002) were evaluated along with BARI SP-3 and

BARI SP-10 used as check during 2019-20 cropping season at five locations (Gazipur, Bogura, Jamalpur, Jashore, and Pahartali) in RCB design with three replications. Red skinned and white fleshed local cultivar WFRS002 found promising regarding their marketable yield, dry matter content and overall acceptability score. Though the weevil infestation found insignificant, even though there were less infestation in the field for all the materials as these are locally adapted.

Regional yield trial with F_1C_7 hybrid clones of sweet potato

Considering marketable yield, dry matter yield, carotene content, overall acceptability score and other factors for hybrid clones namely, $H_{6.52}$/11and $H_{9.48}$/11 may be selected for next year evaluation for more confirmation

Regional yield trail of F_1C_8 hybrid clones of sweet potato

Two promising clones (H_5.ej/10 and H_{16}.ej/10) were evaluated along with BARI SP-4 and BARI SP-8 used as check during 2019-20 cropping season at five locations (Gazipur, Bogura, Jamalpur, Jashore, and Pahartali) in RCB design with three replications. Considering marketable yield, dry matter (%), carotene content, overall acceptability score and other factors two hybrid clones namely, H_5.ej/10 and H_{16}.ej/10 may be selected for next year evaluation.

Participatory variety selection trial with F_1C_7 hybrid clones of sweet potato

A participatory variety selection trial at farmer's field of Bogura, Pahartali and Jamalpur was carried out with two hybrid clones namely $H_{6.52}$/11and $H_{9.48}$/11with two check variety BARI SP-4 and BARI SP-8 during the winter season of 2019-20. Farmers experienced better platability during testing $H_{6.52}$/11. Overall, they choose both $H_{6.52}$/11 and $H_{9.48}$/11 in respect of their marketable yield and organoleptic test.

Participatory variety selection trial with F_1C_8 hybrid clones of sweet potato

A participatory variety selection trial at farmer's field of Bogura, Pahartali and Jamalpur was carried out with two hybrid clones namely $H_{5.ej}$/10 and $H_{16.ej}$/10 with two check varieties BARI SP-4 and BARI SP-8 during the winter season of 2019-20. Farmers experienced platability during testing $H_{16.ej}$/10 & $H_{5.ej}$/10 though they are contrasted with high beta carotene. These two showed high yield potentiality as well. High yielding material $H_{16.ej}$/10 performed the best in Pahartali but it contain low amount of dry matter. Overall they choose both $H_{5.ej}$/10 & $H_{16.ej}$/10 in respect of their marketable yield and organoleptic test.

Aroids

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

Four promising lines of Mukhikachu (*Colocasia esculenta* var. *antiquorum*) viz. MK-122, MK-129, MK-131, MK-176 along with a BARI released variety Bilasi as check were evaluated under regional yield trial at four locations namely Gazipur, Jamalpur, Jashore and Bogura during February to November 2019.The crop was planted following randomized complete block design with 3 replications. The growth parameters, yield components and yield were statistically significant. The check variety Bilasi produced the highest yield (37.2 t/ha) which was statistically similar with MK-129 (35.2 t/ha).

Preliminary yield trial of mukhikachu lines

Fifteen lines of Mukhikachu (*Colocasia esculenta* var. *antiquorum*) viz. MK-105, MK-127, MK-140, MK-177, MK-178, MK-179, MK-180, MK-181, MK-182, MK-183, MK-184, MK-185, MK-186, MK-187 and MK-188 were evaluated under preliminary yield trial during April to November 2019 at TCRC research field, Gazipur. The crop was planted following randomized complete block design with 3 replications.The growth parameters, yield components and yield were statistically significant. The highest yield (12.4 t/ha) was recorded in MK-185 closely followed by MK-127 (12 t/ha) and it was statistically at par with another 8 lines of MK-140, MK-177, MK-178, MK-179, MK-180, MK-181, MK-182 and MK-183.

Advanced yield trial of rhizome producing panikachu lines

Four lines of rhizome producing Panikachu (*Colocasia esculenta*) viz. PK-119, PK-179, PK-

180 and PK-181 along with two released varieties BARI Panikachu-5 and BARI Panikachu-6 as check were evaluated under advanced yield trial at Gazipur, Jamalpur, Bogura and Jashore. The crop was planted following randomized complete block design with 3 replications. Significant variation was observed among most of the growth, yield attributes and yield of rhizome producing Panikachu genotypes. Significantly higher stolon yield obtained in PK-179 at all the studied locations and it was the highest of 24.7 t/ha at Gazipur. In case of marketable rhizome yield, PK-179 followed the same trend of stolon yield. The highest marketable rhizome yield (98.8 t/ha) was obtained in PK-179 at Jashore.

Advanced yield trial of stolon producing panikachu lines

Two lines of stolon producing Panikachu (*Colocasia esculenta*) namely PK-134, PK-178 along with two BARI released stolon producing varieties of Latiraj and BARI Panikachu-2 as check were included in this experiment for selecting new variety(s) under regional yield trial at Gazipur, Jamalpur, Jashore and Bogura during February to August 2019. The crop was planted following randomized complete block design with 3 replications. Most of the vegetative growth, yield contributing characters and yield were statistically significant for interaction effect of the genotypes and locations. Stolon yield was the highest (24 t/ha) in Latiraj at Jamalpur closely followed by PK-134 (22.6 t/ha) at Jamalpur. The marketable rhizome yield was the highest (116.3 t/ha) for BARI Panikachu-2 at Jashore.

Observational trial of ghataman kachu in relation to spacing

Two spacing of 60 cm × 60 cm and 70 cm × 70 cm on Ghataman Kachu (*Aolcasia sp.)* were evaluated during March to December 2019 at the field of Tuber Crops Research Centre, Gazipur. The crop was planted following randomized complete block design with 7 replications.The vegetative growth, yield contributing characters and yield were influenced significantly. The highest yield (42.4 t/ha) was obtained with 70 cm × 70 cm spacing than 60 cm × 60 cm spacing (35.4 t/ha).

Observational trial of panchamukhi kachu in relation to spacing

Two spacing of 60 cm × 60 cm and 70 cm × 70 cm on Panchamukhi Kachu (*Colcasia sp*) were evaluated during March to December 2019 at the research field of Tuber Crops Research Centre, Gazipur. The crop was planted following randomized complete block design with 7 replications. Plant height and weight of individual corm was significantly influenced by spacing. The yield was not statistically significant. The corm yield was around 20 t/ha for both the spacing.

Maintenance of aroids germplasm

Eighteen of Mukhikachu, fifty of Panikachu and one of each of Panchamukhi Kachu, Dudhkachu, Moulovikachu/Sahebikachu and Ghataman Kachu germplasm collected from home and abroad in the recent past years and conserved at TCRC field, Joydebpur, Gazipur.

Minor tuber crops

Regional yield trial of yam (*dioscorea* spp.) germplasm

Five yam germplasm namely HOM 20, HOM 47, HOM 39, HOM 9 and HOM 7 were evaluated at three different agro ecological zopnes during 2019-20 cropping season for RYT. Combined analysis was done to see the genotype location interaction. The significant influence was observed of different environmental factor for different locations on the expression of different characters of yam. HOM-9 gave highest yield 17.54 kg per plant followed by HOM-7 (16.77 kg/plant) and HOM-39 (15.97 kg/plant). Therefore, those may be advanced for releasing as variety considering the result.

Participatory yield trial of yam (*dioscorea* spp.)

Five yam germplasm namely HOM 20, HOM 47, HOM 39, HOM 9 and HOM 7 were evaluated at farmers field of Gazipur during 2019-20 cropping season under PYT. HOM-7 gave highest yield 4.56 kg per plant followed by HOM 20 (4.46 kg/plant) and HOM-47 (4.07 kg/plant). The lowest yield obtained by HOM 9 (3.12 kg/plant). So, those could be advanced to release as variety considering the result.

Conventional production technology

Effect of planting date and spacing on the yield of early harvesting 'baby' potato tubers and their economics

The experiment was conducted at Breeder Seed Production Center, Debigonj during the Rabi season 2019-20 to determine the optimum planting date and spacing to maximize the better economic return of early harvesting 'baby' potato tubers. The treatment comprised four planting dates (3rd Oct., 13 Oct., 23 Oct and 3rd Nov.) and four spacing (50 cm × 25 cm, 50 cm × 20 cm, 40 cm × 25 cm and 40 cm × 20 cm). The experiment was laid out in a randomized complete block design (RCB) with three replications. The yield of potato was significantly influenced by the planting dates. The highest tuber yield (25.6 t/ha) was found at 23rd October planting. Interaction effect of planting date and spacing also significantly influenced on tuber yield, having the highest (29.8 tha^{-1}) at 23rd October planting with closure spacing (40 cm × 20 cm).The highest gross return (521500/ Tk./ha) was also noted in the same combination. Based on three years results, the second to third week of October planting along with the closest spacing (40 cm × 20 cm) may be recommended for baby potato cultivation.

Bulking behaviour of promising potato varieties

The experiment was conducted at Tuber Crops Research Centre (TCRC), Joydevpur during the Rabi season of 2019-2020 to find out the suitable time of harvest for getting desirable yield of promising potato varieties. Four harvesting were done at 10 days interval started from 60 DAP (days after planting) and continued up to 90 DAP. Three promising potato varieties such as BARI Alu-46, BARI Alu-62 and BARI Alu-63 were used as test crop. The highest tuber yield (27.05 t/ha) and maximum dry matter (19.93%) was found in BARI Alu-62. 90 DAP showed significantly higher yield (31.32 t/ha) and dry matter content (22.82%) while the highest yield (37.7 t/ha) and rich dry matter (19.78%) were found in BARI Alu-62 harvested at 80DAP followed by 90 DAP from the same variety.

Intercropping of different vegetables with potato at Munshigonj region

An experiment was conducted during rabi season of 2019-2020 at Tuber Crop Research Sub-Centre, Munshigonj to find out suitable intercrop combination for higher profitability and economic return. Sole potato (100%) and five intercrop combinations (one row of potato and one row of red amaranth, one row of potato and one row of spinach, one row of potato and one row of Reddish, one row of potato and one row of cabbage and one rows of cauliflower in between two rows of potato) were evaluated in the present study. Significantly the highest potato yield (40.7 t/ha) was obtained from sole crops. Potato yield was reduced (7.20-16.12%) due to intercropping, but it was compensated by the intercrop. Moreover, potato equivalent yield (PEY) of the intercrop treatments was higher than those of sole crops. The highest (63.4 t/ha) potato equivalent yield (PEY) was found in one row of potato + one row of cauliflower. The highest gross return (Tk. 316800/ha), net return (Tk. 141000/ha) and benefit cost ratio (1.80) were also recorded in this treatment combination.

Response of potato varieties to water stress conditions

An experiment was conducted at Tuber Crops Research Sub-Centre, Munshiganj during 2019-2020 with four level of irrigations namely I_0 = No irrigation, I_1= One irrigation at 30 DAP, I_2= Two irrigation at 30 and 45 DAP and I_3= Three irrigation at 30, 45 and 60 DAP (Control) with seven newly released potato varieties namely V_1=BARI Alu-25, V_2=BARI Alu-28, V_3=BARI Alu-35, V_4=BARI Alu-36, V_5=BARI Alu-37, V_6=BARI Alu-40 and V_7=BARI Alu-62 with a view to select variety(ies) that are high yielding and suitable for cultivation under water stress condition. Results showed that treatment combination (V_4I_0) and (V_4I_1) performed better in terms of grade of seed size tuber and yield and but considering dry matter percentage treatment combination (V_2I_0) and (V_1I_0) performed better under water stress condition. Therefore, considering the yield, grade of tuber and dry matter percentages BARI Alu-36, BARI Alu-25 and BARI Alu-28 may be cultivated under water stress condition in our country.

Comparison between production system of farmers' and research practice in respect of yield and economic benefit of potato

An experiment was conducted at Tuber Crops Research Sub-Centre, Munshiganj during 2019-

2020 with two varieties namely V_1= BARI Alu-25 and V_2= BARI Alu-37 with two management practices namely P_1= Research practice and P_2= Farmers' practice with a view to compare the yields between the farmers' practice and research practice and find out the better economic output of potato production system. Results showed that considering the tuber fresh yield, tuber dry matter percentage, insect and diseases reaction and economic analysis the best performance was obtained from treatment combination (V_2P_1) and (V_1P_1).

Combined application of biochar with compost and fertilizer for the improvement of soil properties and tuber yield of potato

The experiment was conducted to study the effect of biochar with organic and inorganic fertilizer the improvement of soil chemical, physical, biological properties and potato tuber production. There were eight treatments e.g. T_1. Control (No Fertilizer), T_2. Biochar @ 5 ton/ha (3.6 kg), T_3. Recommended Organic Fertilizer (Vermicompost 3.2 kg, Trichocompost 3.2 kg, NOC 3.2 kg and CD 4.3kg), T_4. Recommended Fertilizer (Urea 252 g, TSP 159 g, MOP 216 g, Gypsum 144 g, $ZnSO_4$ 7.2 g, HBO_3 7.2 g, Sunfuran 14.4 g and CD 7.5 kg), T_5. Fertilizer 75% + Compost 25% (Urea 189 g, TSP 120 g, MOP 162 g, Gypsum 108 g, $ZnSO_4$ 5.4 g, HBO_3 5.4 g, Sunfuran 10.8 g and CD 5.7 kg) + (Vermicompost 800 g, Trichocompost 800 g, NOC 800 g and CD 1075 g), T_6. Recommended Organic Fertilizer + Biochar (T_3+T_2), T_7. Fertilizer 75%+ Compost 25% + Biochar (T_5+ T_2), T_8. Recommended Fertilizer+ Biochar (T_4+T_2).The experiment was laid out in RCB design with three replications. T_8 exhibited the highest yield in each plot (20.38 kg), total marketable yield (27.83 ton/ha) and total yield in hector (28.31 ton) which was followed by T_4 (yield in each plot (18.64 kg), total marketable yield (25.16 ton/ha) and total yield in hector (28.89 ton)).Considering all yield contributing parameters, soil and plant sample analysis, yield and economic analysis it may be concluded that T_4 and T_8 were suitable treatments for recommendation. The highest net return and BCR were recorded in T_4 but if farmers use chimney which would be used for dual purposes like cooking and making biochar (e.g. “Akha biochar device” made by CCDB (Christian Commission for Development in Bangladesh)) they will utilize straw for beneficial purpose like making biochar as bio-product. As a result, the cost of biochar will not be required for its production. On the other hand, no need to use biochar if anyone apply it one time to his land. So from second year, biochar will not be applied to those treatments where it was used and the input cost of biochar will not be included.

Sweet potato and aroids

Effect of urea super granule (USG) on the yield performance of BARI Panikachu 1 (C*olocasia esculenta l.*)

The experiment was carried out at TCRC, Joydevpur during February to September 2019 to evaluate the efficiency of USG application in comparison with prilled urea for sustainable production of panikachu. There were six treatments, T_1= N_{350} (recommended N dose used as prilled urea), T_2=N_{350} (recommended N dose used as USG), T_3= N_{315} (10% reduction of recommended N dose as USG) T_4= N_{280} (20% reduction of recommended N dose as USG) T_5=N_{245} (30% reduction of recommended N dose as USG), T_6= control (native nutrient). 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 application of USG. The highest stolon yield (25.03 t/ha) and rhizome yield (22.74 t/ha) were found in T4 ($N_{280}P_{180}K_{250}$ kg/ha + CD 5 t/ha), 20% reduction of recommended N dose as USG) with highest BCR (2.0). Therefore, 20% reduction of recommended N dose as USG was found as suitable for the cultivation of BARI panikachu-1

Effect of spacing on the yield of BARI Mukhikachu-1

A field experiment was conducted at TCRSC, BARI, Seujgari, Bogura during *kharif*, 2018-19 to find out optimum spacing of BARI Mukhikachu- 1. There were seven treatment viz. T_1=60 cm×35 cm, T_2=70 cm × 25 cm, T_3=70 cm×30 cm, T_4=70 cm×35 cm, T_5=80 cm×25 cm, T_6=80 cm×20 cm and T_7=60 cm×45cm. The yield attributes and yield were significantly influenced by the spacing. The highest corm yield was found in T_2 (70 cm × 25 cm) which was statistically identical to T_6 (80 cm × 20 cm)

Organic production technology

Evaluation of stolon producing taro genotypes under low input organic cultivation system

Three released variety of Panikachu (*Colocasia esculenta* L) namely BARI PaniKachu-1, BARI Pani Kachu-2 and BARI Pani Kachu-3 along with a local line as check were evaluated to find the superior variety under organic cultivation system. This experiment was executed at ‘Organic Block’, TCRC research field, Gazipur over the period from February to August, 2019. Soil fertility and pest management were done following organic practices and standards. Cow dung, Trichocompost and Neem Oil Cake (NOC); each one was applied @ 8t/ha and different botanicals were used to reduce the pest attack. There was significant difference among the varieties in respect of most of the yield contributing characters and BARI Pani Kachu-1 showed better result for most of the parameters. Accordingly, the highest stolon yield (15.9 t/ha) was found from the variety BARI Pani Kachu-1which was followed by BARI Pani Kachu-2 (11.9 t/ha) but it was statistically different. **.**

Efficacy of botanicals to control virus diseases transmitted by aphids in organic potato production.

An experiment was conducted to evaluate the efficacy of five different botanical pesticide to suppress the aphid infestation and therafter incidence of two major virus diseases namely PLRV and PVY in potato field under organic management practices. The experiment was executed at the organic block under TCRC research field, Joydebpur during the year of 2019-20. Five botanicals namely rape seed oil, mahogony oil, neem oil, karam cha oil @ 2 ml/liter and Bioneem Plus (Azadiractin) @ 1ml/litre were chosen as treatment. BARI Alu 36 was used under organic production system where soil fertility was managed with different organic fertilizers like Cow dung, Vermicompost, Trichocompost, and Neem Oil Cake @ 5t/ha each and different treatments were applied at 10 days interval from 30 days after planting to haulm pulling. Mean aphid number per ten plant as well as incidence of PLRV and PVY was recorded at three different dates. In most cases, neem oil performed the better in reduction of aphid infestation as well as viral diseases. Furthermore, plant vigor as well as tuber yield were found better from the plot treated with neem based products.

Effects of different registered organic fertilizers on the yield and yield contributing characters of potato

This experiment was executed at the organic block under TCRC research field, Joydebpur during the year 2019-20 to assess the influence of organic fertilizers on the yield of potato. Performance of four organic fertilizers namely ACI organic fertilizer, North Bengal Organic Fertilizer, Onnopurna organic fertilizer, Mega organic fertilizer with one potato variety e.g. BARI Alu36 was evaluated. ACI Organic Fertilizer with BARI Alu36 gave the highest yield (24.50 t/ha) which was statistically higher than other the treatments.

Evaluation of sweet potato varieties under organic farming system

Fifteen (15) varieties of sweet potato were evaluated to find out superior variety under organic cultivation system. This experiment was executed at ‘Organic Block’, TCRC research field, Gazipur over the period from Nov 2019 to April 2020. Soil fertility and pest management was done following organic practices and standards. Cow dung, Tricho compost and Neem Oil Cake (NOC); each one was applied @ 8t/ha and different botanicals were used to reduce the pest attack. There was significant difference among the varieties in respect of most of the yield contributing character. Accordingly, the highest root yield (22.28 t/ha) was found from the variety BARI SP15 which was followed by BARI SP16 (20.83 t/ha) and was statistically different from all other varieties including check.

Effect of organic herbicides on major weeds species and yield of potato

A field experiment was conducted at ‘Organic Block’ of tuber crops research centre, BARI during rabi season of 2019-2020 to find out the suitable organic herbicide against weeds in organic potato fields. Efficacy of organic herbicides in controlling weeds was evaluated by spraying just after planting and continued 5 days interval till 60 days. There were five treatments viz. T_1 = Salt @ 50kg/ha , T_2 = Vinegar @ 150ml/l , T_3= Neem oil @50 ml/l, T_4 = Eucalyptus oil @50ml/l and T_5 = Control (no weeding), with one potato variety BARI Alu 46. There was significant difference among the treatments in respect of weed control and tuber yield. The maximum weed control efficiency (78.87%) was recorded in eucalyptus oil treated plot (T_4) while the highest tuber yield 29.77(t/ha) was found in neem oil treated plot (T_3) and was statistically similar with T_4 (27.08 t/ha). Significantly lowest yield (20.33 t/ha) was obtained in control plot (T_5) and among the treatments, poor weed control efficiency (51.35%) was observed in salt treated plot.

Tissue culture

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

In vitro plantlets of potato were produced from meristem and virus free potato tubers of different potato varieties and genotypes using MS media under aseptic conditions. A total of 16850 plantlets of BARI released potato varieties was sent to Breeder Seed Production Centre (BPSC), Debigonj during 2019-20 having 3000, 250, 8000, 250, 500, 650, 700, 700, 400, 300, 1150, and 950of BARI Alu-7, BARI Alu-13, BARI Alu-25, BARI Alu-35, BARI Alu-40, BARI Alu-41,BARI Alu-46, BARI Alu-53, BARI Alu-62, BARI Alu-63 ,BARI Alu-72 and BARI Alu-73 respectively. A total 318.0 kg mini tubers of BARI released variety was produced having BARI Alu-35, 16.5kg BARI Alu-37, 35.5kg BARI Alu-40, 21.0 kg, BARI Alu-41, 63.0 kg, BARI Alu-46 ,54.0 kg BARI Alu-47, 3.5 kg ,BARI Alu-48, 2.5 kg, BARI Alu-50, 10.5, kg BARI Alu-53, 11.5kg, BARI Alu-56, 7.0kg, BARI Alu-62 ,22.0 kg , BARI Alu-72, 32.0kg, and BARI Alu-73, 8.0kg, respectively. A total number of 33 BARI released potato varieties are being maintained at Tissue Culture Lab, TCRC for in vitro multiplication. At present a total of 9503 potato plantlets from different BARI varieties are under conservation having from BARI Alu-7, BARI Alu-8, BARI Alu-13, BARI Alu-25, BARI Alu-29, BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-40, BARI Alu-41, BARI Alu-46, BARI Alu-47, BARI Alu-48, BARI Alu-49, BARI Alu-50, BARI Alu-53, BARI Alu-54, BARI Alu-56, BARI Alu-57, BARI Alu-62, BARI Alu-63, BARI Alu-72 , BARI Alu-73 , BARI Alu-76, BARI Alu-77, BARI Alu-80, BARI Alu-81, BARI Alu-83,BARI Alu-86, BARI Alu-87, BARI Alu-88 and BARI Alu-90 respectively. Mother stock of the varieties is being maintained by subcultures for future multiplications and short term conservation.

Production of minituber (G_0) from in vitro plantlets net house conditions

Mini tuber production of potato was done from virus free *in vitro* plantlets of potato at net house of TCRC, BARI during 2019-2020. A total 318.0 kgmini tuber was produced during 2019-20 crop season at net house condition. Number of minituber/plant from BARI Alu-7, BARI Alu-25, BARI Alu-35, BARI Alu-37, BARI Alu-40, BARI Alu-41, BARI Alu-46, BARI Alu-47, BARI Alu-48, BARI Alu-49, BARI Alu-50, BARI Alu-53, BARI Alu-46, BARI Alu-47, BARI Alu-48, BARI Alu-50 , BARI Alu-53, BARI Alu-56, BARI Alu-62, BARI Alu-63, BARI Alu-72 and BARI Alu-73 were 11.86, 8.8, 20.86, 17.13, 18.8, 26.13, 18.6, 18.8, 21.4, 17.8, 19.6, 12.73, 15.13, 19.5, 18.09 and 13.6, respectively. The maximum weight was observed from by the variety BARI Alu-41 (286.2 g) followed by BARI Alu-72 (267.6g), BARI Alu -46 (261.26g), BARI Alu -62 (234.86g), BARI Alu-50 (233.7g) ,BARI Alu -47 (226.4g), BARI Alu 37(217.6g), BARI Alu-35(217.6g), BARI Alu-40 (195.2g), BARI Alu-7 (154.46g), BARI Alu-53 (143.6g), BARI Alu-73 (139.6g) , BARI Alu-48 (133.4), BARI Alu-25(93.2g), BARI Alu-56(84.26g) and BARI Alu-63(42.5g).

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

Meristem culture has become a powerful and successful tool for virus elimination from virus infected plants and has been successfully applied in potato. Tubers of five IPV (Shilbilati, Lalpakhri, Sadaguti, Jam Alu and Patnai) were collected from different locations of Bangladesh. To test the virus infection tubers from each cultivar were subjected to DAS-ELISA test. Virus infected tubers were chosen and used for sprout production. The sprouted potato cultivars were planted in pots containing fine heat sterilized sand under greenhouse conditions. When potato plants grew sufficiently (about 30-40 days old shoot.) the meristem part was taken from leaf buds. A total of forty three meristems were isolated and cultured from three indigenous varieties namely Shilbilati, Lalpakhri and Ausha on basal MS media. Out of forty three meristems, DAS ELISA test was conducted on twelve meristem derived plantletsand virus free plantlets were not obtained, others plantlets have been sub cultured and will be tested for DUS-ELISA.

Tissue culture of cassava (*Manihot Esculenta* Crantz) germplasm

Tissue culture of cassava (*Manihot Esculenta* Crantz) germplasm was conducted at tissue culture lab, TCRC in BARI during 2019-2020 with a view to establish a protocol for *in vitro* multiple shoot production. Plantlets of thirty eight genotypes were collected from Vietnam in 20 July 2017. In vitro plantlets were used as a explants source for micro propagation. MS media supplemented with 1.0 mg/l BAP showed the good response for shoot induction. After 5 weeks, shoots were cultured in rooting media. MS media supplemented with 0.5 mg/l NAA produced 5-6 roots per plantlets. A total of 110 plantlets were obtained from eight genotypes after sub culture. Plantlets were transferred into field after successful hardening. MS media supplemented with (1.0mg/l) BAP was used for shoot development and after 5 weeks 3-4 nodes were obtained .For root development MS media supplemented with 0.5mg/l NAA were used and at least 5- roots were obtained from each plantlet after 4-5 weeks. The rooted plantlets were then selected for next step hardening.

***In vitro* propagation of stress tolerant potato varieties and standardization of nutrient film technique protocol for quality seed production**

To start the experiment a 10 feet x 4 feet table was setup using circular irrigation system. After developing NFT structure, 3 popular varieties such as BARI Alu-7 (Diamant), BARI Alu-46 and BARI Alu-72 were used in this NFT system. Plantlets from Tissue culture were taken at the age of 28 days and then put them first in hardening stage. After hardening, plantlets were planted in sand tray to get more harden. After 10 days sand planting, all the plantlets were transplanted on January 26, 2020 to NFT system giving space plantlets 15 cm apart. Plantlets from tissue culture were planted in wool rock in 15 cm apart on the tray where nutrients were support from the reservation from the reservoir. The experiment was conducted in TCRC greenhouse. Plantlets were growing excellent and vigorous, but root of plantlets got rotten and leaves were burned. The main reason for that was lack of enough moisture/ humidity in the greenhouse room. For these reasons, the experiment was not possible to complete for better growth of the plants in the greenhouse, at least 60-80% humidites required. Root rotten found more in BARI Alu-7 (Diamant) variety. This experiment needs to be conducted again under optimum greenhouse condition.

Molecular genetics and breeding

Fingerprinting of indigenous potato varieties of Bangladesh using SNP marker

Twenty-one indigenous potato cultivars (IPVs) of Bangladesh have been selected for fingerprinting. This experiment was conducted jointly with Molecular biology lab, TCRC, BARI, Gazipur, and Michigan State University, USA. Genomic DNA extracted from young leaves/tuber using Pro mega genomic DNA extraction kit following manufacturer’s protocol. DNA samples from 21 IPVs were analyzed using SNP primers. The 21 samples were assayed on the Potato V2 SNP array. The V2 array has 12808 SNPs. The tetraploid model was also used to take a first look at the phylogeny using hierarchical clustering. There were 3857 SNPs with < 10% No-Calls in all 28 samples (21 BGD samples plus seven reference samples). The genotypes were 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 from 6 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.

Fingerprinting of BARI released cloned potato varieties using SSR marker

The study was conducted using BARI released clone potato varieties. These varieties were developed through hybridization by TCRC. DNA-based fingerprinting using SNP marker was shown to discriminate between potato clones. The objective of this study was to identify and distinguish accurately and efficiently clone potatoes for an applied fingerprinting system of cultivated potato. SSR primer pairs with high polymorphism were selected from previous tetraploid potato studies. DNA isolated from 14 potato clones were visualized on polyacrylamide (PAGE). Polymorphism was observed in all 18 primer combinations on PAGE. All 12 cultivars were discriminated on PAGE with various combinations of eighteen primer pairs. The UPGMA cluster analysis led to the grouping of the 12 varieties in two major clusters I and II. It was observed that three varieties were at cluster I and nine varieties found at cluster II. In cluster I, BARI Alu-35 and BARI Alu-40 showed 100% genetic similarity and clustered together those were also 80% similarity with BARI Alu-50. Cluster II was divided into three groups (G_1, G_2 and G_3) where G_1 contained three cloned potato varieties BARI Alu-48, BARI Alu-62 and BARI Alu-63 where BARI Alu-48 showed genetic similarity with BARI Alu-62 and BARI Alu-63 by 78% and 75%, respectively. On the other hand, BARIAlu-36, BARI Alu-37, BARI Alu-41 and BARIAlu-56 grouped together where BARI Alu-37 and BARI Alu-41 showed higher genetic similarity (80%) as well as BARI Alu-36 and BARI Alu-56 showed 76% genetic similarity. But, BARI Alu-47 and BARI Alu-57 showed 69% similarity that formed G_3. Besides, dendrogram showed that lower genetic similarity (63%) between BARI Alu-48 and BARI Alu-57.

Molecular characterization of BARI released sweet potato varieties using SSR marker

The study was conducted at Molecular Biology Lab, TCRC, BARI, Gazipur during 2019-20. In this study, genetic diversity of 15 BARI released sweet potato varieties using microsatellite markers was determined. A total of 15 sweet potato varieties were selected for the present study. DNA was isolated from fresh young leaves following the protocol of CTAB with some modifications. The quantity and quality of extracted DNA was tested at 260 nm absorbance reading (Thermo Scientific, Nanodrop 2000. Ten pairs of SSR primers were used for the sweet potato DNA amplification reactions. Product resulting from amplification were separated by electrophoresis on 5% polyacrylamide gels in a TBS running buffer under a constant voltage of 80 V for 2 hours in a vertical vessel (20x20cm). They were analyzed for diversity using 10 simple sequence repeat (SSR) primers. The presence of bands was scored for each SSR and for each variety and the data were analysed by principal coordinate analysis. The polymorphic SSR loci revealed diverse relationship among the sweet potato varieties, which was grouped into two major cluster by unweighted pair group method analysis (UPGMA). Cluster analysis showed a jaccard co-efficient ranging from 0.00- 0, 81 indicating high genetic diversity among those varieties.

Chloroplast genome sequencing and QTL analysis of heat tolerant and late blight resistant potato varieties

This basic research project was proposed for four years. Protocols for Chloroplast and chloroplast DNA isolation were optimized and cpDNA was isolated. Samples are under processed for sequencing from abroad. There were 17 progenies developed through crossing between heat tolerant and late blight resistant potato varieties (BARI Alu-46, 53, 72 and 73) with susceptible ones (BARI Alu-7, 8 and 25). There were a lot of variations among the progenies found in Rangpur for late blight disease resistance. Form the TB08 population, maximum progenies were found susceptible to late blight only two lines (TB8-076 and TB8-079) were found good resistance. Lines TB10-073, TB10-136, TB10-139 and TB10-162 showed resistance to late blight. In both populations, some showed moderate resistance to late blight. Resistance was measured by susceptibility scale as well as rAUDPC. RADPC will be used in map QTL development. Heat tolerant map QTL would be developed from the lines planted in BSPC. Tubers were planted at late season to get heat/ drought at the end of the season, but due to heavy raining plants did not get any water scarcity and no wilting in the plants. Some important data were taken except wilting behavior under water stressed condition after 60 DAP. Higher the plant vigor higher the heat tolerant, but more information on wilting needed. This data will be taken at coming growing season. Final conclusion will be drawn after completion of the project.

Secondary observation trial of combined PVY and PLRV

The M2 and M3 populations were planted at BSPC research field during 2019-2020 to find out superior lines of PVY and PLRV resistance which were developed by MAS and ELISA. Their yield performances with our control varieties BARI Alu-7 (Diamant) and BARI Alu-25 (Asterix) were also evaluated. Genetic Markers were used to screen those lines in previous year using DNA from the young leaf tissue. In 2017-18, 133 lines planted and from them 80 lines were virus-negative. ELISA test was done for 64 lines and from them 45 lines found combined PVY and PLRV virus-free and resistance to PVY and PLRV of potato. Tubers of them were kept and 35 lines out of 45 planted this year to look at the yield performance. Some lines were found round and some of them produced more than 40 t/ha yield.

Secondary yield trial (SYT) of anthocyanin rich potato germplasms

Four exotic varieties along with 5 check varieties BARI Alu-7 (Diamant), BARI Alu-8 (Cardinal) BARI Alu-25 (Asterix) BARI Alu-53 and BARI Alu-82 (L. Rosetta) were evaluated at two different agro ecological locations of Bangladesh (Debiganj and Gazipur) during 2019-20 for second generation trial. The significant influence was observed under different environmental factors of different locations on the expression of different characters of potato. The mean performance of selected genotypes over locations was statistically significant. The ranges of days to plant stand at 30 DAP 43.33-54.33, plant height at 65 DAP 77.03-99.99 cm, stem number per plant at 65 DAP 2.96-5.20, plant vigour at 10 scale 7.66-9.33, tuber number per plant 7.02-8.89, tuber weight per plant 0.31-0.45 Kg and yield 30.26-36 t/ha were found in TCRC research field. In Gazipur location, the variety Katahdin was germinated more plants in 30 DAP (54.33 out of 60 plants), followed by BARI Alu-53 (49.00). Plat height was found highest in BARI Alu-53 ((99.99cm) followed by BARI Alu-82 (92.02cm). The highest stem number per plant (5.20), plant vigour (9.33) and tuber number per plant (8.99) were found in Red Marker#2. Tuber weight per plant in Gazipur was found highest in BARI Alu-07 (0.45 kg followed by BARI Alu-82 (0.44 kg). Except Red Marker#2, all all the varieties were statistically significant in Gaziur. The ranges of tuber number per plant 10.55-20.71, tuber weight per plant 0.57-0.97 kg and yield 308.35-65.13 t/ha were found in BSPC research field. In BSPC, Debiganj location, the variety BARI Alu-53 produced the highest number of tuber plant (20.71) followed by BARI Alu-8 (Cardinal). Tuber weight found highest (0.97 kg) in BARI Alu-8 (Cardinal). Tuber yield per hectare was found statistically significant in all the varieties except MSZ219-13. In the both cases tuber grade by number (%) and weight (%), most of the breeding lines produced desired number of medium size tubers (28-40) and 40-55 mm size) at all the location. Seed tuber grade percentage showed satisfactory performance among the genotypes and over the locations. Finally exotic variety MSZ109-10PP, Red Marker can be selected for AYT on the basis of field performance for nutrient rich category, Katahdin for earliness and high yielder, MSZ219-13 for scab resistance.

Characterization of R-genes for late blight disease of potato

Resistant varieties along with susceptible varieties were planted in TCRC, Gazipur and RARS, Rangpur. In Gazipur and Rangpur BARI Alu-90 and BARI Alu-46 produced highest yield vice versa. Highest yield recorded in Rangpur was 40.86 t/ha followed by 39.10 t/ha by BARI Alu-90. In both locations, Katahdin had highest late blight disease infection (65% in Gazipur and 68.33 in Rangpur). Varieties with fungicide spray produced highest yield in both locations. Same type of yield were found for interaction of varieties and spray management. Even in the late blight infection in the varieties by with or without spray. The lowest rAUDPC was found in BARI Alu-46 (0.02) in TCRC, Gazipur and in BARI Alu-90 (0.03) in RARS, Rangpur for the spray schedule. In non-spray condition, BARI Alu-77 and BARI Alu-91 had lowest rAUDPC (0.01) in Gazipur and BARI Alu-77and BARI Alu-90 (0.08 and 0.13) in Rangpur. The lowest yield loss in BARI Alu-46 (9.11%) of TCRC research field and BARI Alu-77 (9.18%) in RARS, Rangpur. For exploring R-gene in the resistant varieties, DNA was isolated, purified and quantified to run PCR with selective R-gene markers. PCR analysis was done and found Phu6, apbt, sto1, and blb1 R-gene in BARI Alu-46, 53, and 57.

Table 1. Varietal effect on the yield production and late blight infection in TCRC, Gazipur and RARS, Rangpur during 2019-20

Varieties	Yield (t/ha)		Late blight infection (%)	
	TCRC, Gazipur	RARS, Rangpur	TCRC, Gazipur	RARS, Rangpur
BARI Alu-07	25.45 cd	31.21 e	25.00 c	65.00 a
BARI Alu-25	-	34.51 d	-	60.83 a
BARI Alu-46	30.37 ab	40.86 a	20.83 c	20.83 c
BARI Alu-53	24.16 de	37.62 bc	38.33 b	40.83 b
BARI Alu-57	21.57 e	35.64 cd	59.83 a	35.00 b
BARI Alu-77	27.75 bc	38.02 b	7.500 d	16.66 c
BARI Alu-90	32.93 a	39.10 ab	4.166 d	12.50 c
BARI Alu-91	27.07 cd	34.72 d	3.00 d	17.66 c
Katahdin	17.46 f	31.04 e	65.00 a	68.33 a
MSZ109-10pp	13.98 g	-	64.66 a	-
Red Marker	16.65 fg	-	61.66 a	-

Introgression of disease resistance r-genes RPI-PHU6 and RPI-STO1 in tetraploid potato for late blight

Late blight population of BARI Alu-46 x BARI Alu-53 (TB11) was planted in RARS, Rangpur on December 5, 2019. BARI Alu-46 contains three R-genes, Rpi-phu6, apbt, sto1 and BARI Alu-53 contains Rpi-phu6 and abpt. The TB11 population was developed from the cross of BARI Alu-46 x BARI Alu-53 in 2017-18. In 2018-29, tubers were produced from this TB11 population in BSPC, Debiganj during 2018-19. Total progenies were 93. In this experiment, with those progenies, BARI Alu-7, 46 and 53 were planted in RARS, Rangpur with 3 replicationsto select the best lines due to introgression of the Rpi-ph6 and rpi-sto1 genes. There were a lot of variations among the progenies found for late blight disease resistance. In this TB11 population, 92 lines were planted along with their parents and susceptible control. Wide range of variations for late blight resistance found due to segregation of resistance genes from the parents of BARI Alu-46 and BARI Alu-53. From them 21 lines found promising performance against late blight disease this year. In TB11population, some was showed moderate resistance to late blight. Resistance were measured by susceptibility scale as well as rAUDPC. RADPC will be used in map QTL development. The best 21 lines will be planted in the field next year and DNA isolation will be done to know the what combination genes are presence in these lines.

Molecular detection of different strain of PVY and PLRV diseases in Bangladesh

Local potato germplasm infected with virus diseases were collected and planted them in Tuber Crops Research Centre, Joydebpur, Gazipur in 2019-20 to see their virus presence. Tubers from each accession were planted in 3m long plot. Whole tubers were planted with a spacing of 60cm × 25cm. Planting was done during the last week of December, 2019. Visual infection for viral disease identification was done in the age of 60 DAP. Tubers from virus infected plants were collected and kept them for isolation of RNA and to sprout them for ELISA test. Currently tubers were placed to get sprouts for ELISA test. After getting ELISA test, confirmed specific virus infected tubers will be used for RNA isolation for checking their different virus strains in Bangladesh. Primers for the specific potato viruses were selected from the published papers. Tubers from the infected tubers were harvested and sort the better size and shape out for using next year trial. Infected tubers were collected from RARS, Rangpur and Jamalpur. Most of the indigenous potato germplasm possessed different types of virus. Most found PVY, PLRV and PVM. Some germplasm had mixture of virus symptom. All the tubers produced from virus infected potato plants were stored for ELISA test and RNA isolation. Tubers will also be used next year trial to see their virus presence in their next generation.

Screening of wild diploid potato genetic resources for combined resistance to late blight, scab and virus diseases

A and B population were planted in BSPC, Debiganj and RARS, Rangpur in 2019-20 to screen them out from virus, scab and late blight diseases. Visual inspection of virus infection and late blight of potato were recorded both in BSPC and RARS, Rangpur, respectively. Scab disease was not observed in this year of experiment. In virus infection, PLRV and PVM were observed and recorded in their specific clones of diploid resources. From A population, 99 clones and 62 clones of B population were produced and 120 clones were infected with PLRV and PVM, collectively in BSPC. However, 149 and 54 clones did not show PVM and PLRV infection, respectively, but out of 161 lines, only 41 lines did not have any infection of virus. For late blight, populations were observed in RARS, Rangpur and no one found resistance to late blight. All tested materials were 100% infected with late blight disease and found dead within 60 days of planting.

Determination of ploidy level of indigenous potato varieties/germplasms

The local potato varieties were collected from Rangpur and Jamalpur and planted in the field net house in TCRC during 2019-20 for the observation of ploidy level. From RARS, Rangpur 9 varieties were collected and planted them along with 11 varieties from RARS, Jamalpur. Along with them, BARI Alu-8 (Diamant) and BARI Alu-25 (Asterix) were used as control of tetraploid varieties. Based on the highest ratio of Diamant, all the germplasms were compared with it using average two ratios of leaflets of each variety. In Rangpur, only Challisha showed diploid nature of leaflet ratio. From Jamalpur, Burma Dhaperhat, Challisha, Jam alu and Patnai were observed diploid leaflet ratio compared with Diamant leaflet ratio.

Dihaploid production from potatoes of 4X-genotypes by anther culture

Potato (*Solanum tuberosum* L. Ssp. tuberosum) was one of the first crop plants in which haploid techniques were used to improve cultivar breeding programmes. These new breeding tools were introduced towards the end of the 1950s but have not totally replaced the conventional breeding of potato at the tetraploid (2n = 4x) level. Generally (di) haploid (2n = 2x) lines are produced by pollination of cultivated potato and related Solanum species with specific haploid inducer clones of S. phureja or alternatively by anther culture in vitro. The resultant clones provided excellent material for the subsequent reconstitution of the polyploid hybrids having maximized heterozygosity levels. Therefore, the haploids have a considerably significant role in the potato breeding programs. Desired variety, BARI Alu-25 (Asterix), and BARI Alu-62 were planted in crossing block conditions to get anthers frequently for haploid production of potato. Anther culture was doing with the variety of BARI Alu-25 (Asterix) and BARI Alu-62. Plants were grown up for flower bud collection. After the collection of flower buds of BARI Alu-25 (Asterix) and BARI Alu-62, an appropriate protocol was followed and placed in a rotary shaker in Linsmaier and Skoog (1965) media for 6 weeks. Linsmaier and Skoog media were better to get embryos. In Gamborg's B5 media, embryos were got dried and black in color. No regeneration happened from the embryos.

Genetic engineering

In vitro regeneration of sweet potato (*Ipomoea balatas* L)

In vitro plantlets were established from nodal explants . 0.5 mg/l Kin was used in BAP supplemented with MS media according to (0.0,.0.5. 1.0, 1.5, 2.0 mg/l). Among these combination MS+ 2.0mg/l BAP +0.5mg/l Kin showed the best results in case of no,.of nodes and no. of leaves/plantlet for both varieties, BARI SP-4 and BARI SP-8. For regeneration study and development of transformation protocol internodes, petioles, leaf segments of in vitro plantlets were used for callus formation. Explants were cultured on Mur ashige and Skoog (MS) media supplemented with six combinations of 2,4-D (0.5,1.0, 1.5,2.0, 2.5 and 3.0 mg/L) and 6-benzylaminopurine (BAP) 0.5 mg/L. Friable callus was obtained with both varieties from internodes and petioles cultured on MS media supplemented with 3 mg/l 2,4-d+ 0.5 mg/L BAP after 45 days of inoculation. Maximum number of friable Callus were obtained from Internodes and petioles of BARI Misti Alu-4 and BARI MistiAlu -8 after 45 days of cultured on MS media supplemented with 3.0mg/L 2,4-D + 0.5mg/L BAP (T_6).

Table 1. Mean effect of plant growth regulators (BAP and Kin) on shoot induction and growth related parameters of BARI Misti Alu-4 and BARI MistiAlu-8 varieties after 30 days of cultured

Variety name	Hormone concentration		Number of shoot/ explant	Number of node/plantlet	Number of leaf/plantlet	Nunber of root/plantlet
	BAP (mg/l)	Kin (mg/l)				
BARI Misti Alu-4	0.0	0.0	1	5.2	6.5	2.5
BARI Misti Alu-8			1	4.9	6.0	1.8
BARI Misti Alu-4	0.5	0.5	1	3.0	4.0	4.0
BARI Misti Alu-8			1	4.0	4.0	1.5
BARI Misti Alu-4	1.0	0.5	1	4.0	4.1	4.0
BARI Misti Alu-8			1	4.0	4.0	4.0
BARI Misti Alu-4	1.5	0.5	1	4.4	5.2	2.2
BARI Misti Alu-8			1	4.8	5.2	2.2
BARI Misti Alu-4	2.0	0.5	1	5.8	6.8	2.8
BARI Misti Alu-8			1	6.4	7.0	3.2

Table 2. Characteristics of callus obtained from different explants of BARI Misti Alu-4

Treatments	Name of variety	Callus Type from explants		Callus colour from explants		Required days for callus formation
		Internodes	Petioles	Internodes	Petioles	
T_1	BARI Misti Alu -4	-	-	-	-	45
T_2		-	-	-	-	45
T_3		-	-	-	-	45
T_4		Firable	Firable	yellow	yellow	45
T_5		Firable	Firable	Cream	Cream	45
T_6		Firable	Firable	yellow	yellow	45

Table 3. Characteristics of callus obtained from different explants of BARI Misti Alu-8

Treatments	Name of variety	Callus Type from explants		Callus colour from explants		Required days for callus formation
		Internodes	Petioles	Internodes	Petioles	
T_1	BARI Misti Alu -8	-	-	-	-	45
T_2		-	-	-	-	45
T_3		-	-	-	-	45
T_4		Firable	Firable	Cream	yellow	45
T_5		Firable	Firable	Cream	Cream	45
T_6		Firable	Firable	Cream	yellow	45

Development of 3R-gene late blight resistant potato variety in Bangladesh

Late blight caused by *Phytophthora infestans* is a devastating disease in cultivated potato throughout the world which can cause yield loss up to 80%. In Bangladesh, farmers use 500 tons of fungicides to protect the crop at a cost of around 100 crore taka. Tuber Crops Research Centre (TCRC), BARI, Michigan State University (MSU), USA and Simplot Plant Sciences Co., USA have been working jointly to develop a 3R-gene GM potato variety for late blight disease resistance. Three late blight R-genes viz. *Rpi-mcq1*, *Rpi-blb2* and *Rpi-vnt1.1* were isolated from *Solanummochiquense*, *S. bulbocastanum* and *S. venturii*, respectively. Simplot Plant Sciences Co. engineered the 3R-gene containing plasmid vector pSIM4392 to transform the GM Diamant events using *Agrobacterium* mediated plant transformation. Ten 3R-gene events were selected as late blight resistant with a single insert of the tDNA by Simplot Plant Sciences Co. These events undergoing molecular screening and field trials for efficacy against the *Phytophthora* isolates at MSU. Pending regulatory approval from Bangladesh authorities, the two best performing GM events will be imported in Bangladesh for contained (CT) use and confined field trial (CFT) during the next potato growing season. The most superior event will be released as a new potato variety after full regulatory approval, following regulatory and multi-locations trials. For efficacy testing, *Phytophthora* isolates were collected from different agro-ecological zones of Bangladesh and molecular based diversity of pathogens was analyzed. *P. infestans* found in Bangladesh when Blue 13 and Pink 6 isolates showed both A1 and A2 mating types. Pure cultures of *Phytophthora* isolates have been made at Plant Pathology lab of TCRC that will be used for artificial inoculation during contained use, confined field trial and regulatory trials of GM potato events.

Survey, collection, isolation and maintanance of late blight of potato and tomato caused by *phytophthora infestans* in Bangladesh under FTFBPP project during 2019-20

The survey work was conducted for observing the status of late blight disease of potato and tomato in Bangladesh. The severity of late blight varied region to region and also in respect of different varieties and found higher to mild throughout the Bangladesh. A total of 220 potato and 39 tomato samples under different divisions were pasted in FTA cards for diversity analysis in USA. The pure culture of *P. infestans* from potato and tomato was isolated successfully from different regions of Bangladesh. Twenty six isolates of *P. infestans* from potato and 2 isolates from tomato were isolated and maintained properly in pea agar media. Two races viz. Blue-13 and Pink-6 were identified through molecular analysis having two sex types.

Seed production

Production of nucleus seed potato (mini tuber, G_0) using *in vitro* plantlet

This work was carried out to produce high quality minituber from in vitro plantlet. The Production of minituber was carried out at BSPC, Debiganj During 2019-20. At first, the plantlets (6 cm height) are transferred to *ex vitro* condition in pot filled with a mixture of sand, decomposed cowdung, burnt rice husk and coconut dust (1:1:1:1v/v) on 18 October 2019. After two weeks, the plantlets were transplanted in soil bed under net house. Beds were consisting of (4.5m by 1.25m) and drenched with fungicides before planting. Three to four water sprays were given daily with a sprayer to keep the soil moist and maintained humidity for initial one week. Secondly the plantlets were transferred direct into the soil on 5 November 2019 under net house. Spray fungicide every morning and watering was done 4 to 5 times for one week to maintain proper soil moisture and humidity. The net house was covered by the gunny/Jute fabric/hessian/thin jute cloth in daytime to protect the plantlets from direct sunlight and keep the temperature low inside the net house and uncovered the net house in the evening for one week. Additional soil substrate added on nursery beds to bury lower nods. The crop was allowed to mature and mini-tubers were harvested. The mini-tubers were kept in the cold storage and it will be used as planting material in the next crop season for breeder seeds production. A total of 3002.35 kg mini-tubers were produced from 47215 plantlets (Table-1 to table-2 and table-3) during 2019-20 crop season at Debiganj. CIP Biofortifide accessions were multiplied for next year trial setup at different location. The highest amount was contributed by the variety BARI Alu-25 (Asterix) 558 kg.

Production of breeder and foundation potato/80 seed at BSPC, Debiganj, Panchagarh during 2019-2020

During 2019-20, 130 acres of land were under seed potato production. Of which 77.25 acres were under nucleus seed (minituber) and breeder seed production program (285 field net house-FNH and 3 permanently built net house-PNH). Rest area was covered with foundation seed (open field), true potato seed (TPS) and research activities. Under PNH 23 varieties (BARI Alu-7 (Diamant), BARI Alu-13 (Granola), BARI Alu-25 (Asterix), BARI Alu-28 (L. Rosetta), BARI Alu-29 (Courage), BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-40, BARI Alu-41, BARI Alu-46, BARI Alu-47, BARI Alu-48, BARI Alu-49, BARI Alu-50, BARI Alu-53, BARI Alu-56, BARI Alu-57, BARI Alu-62, BARI Alu-63, BARI Alu-72,and BARI Alu-79) and CIP clones were grown to produce nucleus seed (minituber) from in vitro plantlets. Sixteen varieties (BARI Alu-7 (Diamant), BARI Alu-8 (Cardinal), BARI Alu-13 (Granola), BARI Alu-25 (Asterix), BARI Alu-28 (L. Rosetta), BARI Alu-29 (Courage),BARI Alu-47, BARI Alu-62, BARI Alu-72, BARI Alu-73, BARI Alu-79, BARI Alu-80, BARI Alu-81, BARI Alu-90 and BARI Alu-91) were grown under temporary field net house to produced breeder seed. For foundation seed production 37 varieties were grown in open field condition. Standard seed production procedure (land selection, land preparation, manure and fertilizer application, planting of seed tuber, earthing up and ridging, mulching, weeding, side dressing, irrigation, rouging, spraying of fungicides and insecticides, haulm pulling, harvesting, sorting, grading and storing) were strictly followed developed by TCRC. In some areas of foundation seed potato were produced mechanically with BARI potato planter and harvester. The production of nucleus seed (mini-tuber), CIP biofortifide nucleus seed, breeder seed, first generation (G_1) Seed, second generation (G_2) seed, foundation seed, experimental materials (Germplasm) and CIP materials were 2.64225, 0.361, 264.662, 57.145, 70.895, 343.007, 25.00 and 4.139 t respectively. BSPC supplied 142.55 ton breeder and 55.95-ton foundation seed to BADC on the last year 2019-20.

Table 1. Total potato seed produced (class wise) at BSPC, Debiganj during 2019-20

Sl. No.	Classes of seed	Seed sold before storing (ton)	Seed supply to BADC (ton)	Seed stored (ton)	Total (ton)
1.	Nucleus seed (mini-tuber)	-	-	2.64225	2.64225
2.	CIP Biofortifide Nucleus seed	-	-	0.361	0.361
3.	Breeder seed	8.432	142.55	113.68	264.662
4.	First generation (G_1)Seed	-	-	57.145	57.145
5.	Second generation (G_2) Seed	-	-	70.895	70.895
6.	Foundation seed	66.639	55.95	220.418	343.007
7.	Experimental Materials (Germplasm)	-	-	25.00	25.00
8.	CIP Materials	-	-	4.139	4.139
	Total =	75.071	198.50	494.28025	767.85125

Table 2. Breeder seed production of different potato varieties at BSPC, Debiganj during 2019-20

Sl. No.	Varieties	Supply to BADC (ton)	Seed sold (ton)	Seed stored (ton)	Total (ton)
1	BARI Alu-7 (Diamant)	-	0.355	2.00	2.355
2	BARI Alu-8 (Cardinal)	-	1.01	-	1.01
3	BARI Alu-13 (Granola)	-	2.710	-	2.710
4	BARI Alu-25 (Asterix)	140.55	4.337	64.93	209.817
5	BARI Alu -28 (Lady Rosetta)	-	0.005	4.895	4.90
6	BARI Alu-29 (Courage)	-	0.01	17.05	17.06
7	BARI Alu 47	1.00	-	-	1.00
8	BARI Alu-62	1.00	-	-	1.00
9	BARI Alu -72	-	0.005	3.96	3.965
10	BARI Alu -73	-	-	6.82	6.82
11	BARI Alu -77	-	-	1.76	1.76
12	BARI Alu -78	-	-	4.73	4.73
13	BARI Alu -79			2.42	2.42
14	BARI Alu -81	-	-	2.42	2.42
15	BARI Alu -90	-	-	1.595	1.595
16	BARI Alu -91	-	-	1.10	1.10
	Total =	142.55	8.432	113.68	264.662

Performance of CIP bio-fortified potato germplasm under aeroponic culture

Potato (*Solanum tuberosum* L.) productivity is highly constrained by limited supply of high quality seed tubers in Bangladesh. Production of TC-based seed potato starts with meristem tip culture technique. The resultant plantlets are grown in net-house for production of mini-tubers. This method is expensive and time consuming due to limited productivity. To overcome this situation Aeroponics is an excellent modern technique. In 2019-20 cropping year, an Aeroponics experiment was set up in the greenhouse of Tuber Crops Research Centre, BARI, Gazipur in order to investigate its feasibility and optimization of production system. Result of this experiment was very promising. CIP-435 gave the highest number of mini-tuber and its weight was maximum among all germplasm. CIP-435 also produced maximum number of leaf and stolon. CIP-403, CIP-415, CIP-424, CIP-426, CIP-428 and CIP-435 were good performer for mini-tuber production in aeroponic culture. The highest number of stolon produced by CIP-403 (14.5) and CIP-427, CIP-435 and CIP-441 produced 13, 9.5 and 10 in each plant respectively. From the aeroponic structure about 7 kg mini-tubers were obtained

Performance of different potato varieties on aeroponics system in seed potato production

In 2019-20 cropping year, an Aeroponics experiment was set up in the greenhouse of Tuber Crops Research Centre, BARI, Gazipur in order to investigate its feasibility and optimization of production system. Result of this experiment was very promising. The maximum number of mini-tubers produced per plant ranged between 3-137 in BARI Alu-47, and the highest yield per plant ranged between 6-1051 g in BARI Alu-72. The average number and weight of mini-tubers per plant were 26.86 and 161.80 g, respectively. On the other hand, altogether, a 4.5m x 1.5m x 1.2m Aeroponics structure produced 18.12 kg mini-tubers and the number of mini-tubers was 3008. On the other hand, on Aeroponics structure-2, a total of 3026 mini-tubers were harvested (29,141 g). The highest average number of tubers per plant was recorded in BARI Alu-46. The maximum number and weight of tubers per plant ranged between 29-73 and 561-977 were recorded in BARI Alu-46. The highest total weight of tuber per variety 3853 g and 17560 g were recorded in BARI Alu-46 and BARI Alu-37 according to their number of plants.

Soil, Water and Nutrient Management

Soil is the most important natural resource of Bangladesh and judicial soil management is the most important for getting desired yield and keeping the soil with full potential for further cultivation. Due to high cropping intensity, soil resource of Bangladesh has been over exploited and soil fertility declines. Soil, water and nutrient management section is currently working on soil fertility and organic matter enrichment through INM and IPNS system of tuber crops cultivation.

Effect of zinc on biochemical parameters, for processing quality and zinc bio-fortification in potato tuber

Zinc was evaluated on the quality of potato tuber and zinc concentration in tuber as bio-fortification at Non-calcareous Grey Floodplain soil of Debiganj and Grey Terrace Soil of Joydebpur. There were five treatments - T_1 (0 kg Zn/ha), T_2 (1.5 kg Zn/ha), T_3 (3 kg Zn/ha), T_4 (4.5 kg Zn/ha) and T_5 (6 kg Zn/ha). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The yield of potato tuber was significantly influenced by different levels of zinc. The highest potato tuber yield (47.1 t ha^{-1}) was found in T_3 at Debiganj followed by T_4 (43.9 t ha^{-1}) at Debiganj. The crop response to fertilizer application was positive and quadratic in nature. From the quadratic response function, the optimum dose of Zn was recorded as 3.52 and 3.63 kg ha^{-1} for Joydebpur and Debiganj, respectively. The highest dry matter content (22.1 and 21.5% for Debiganj and Joydebpur, respectively) was found in T_3. The lowest cutworm infestation was noted in T5 followed by T_3. The highest specific gravity and TSS were recorded in T_3 and T_4, respectively while no scab infection was found in the plots. The other parameter will be incorporated after receiving the lab analytical report. This is the second year result and it will be continued in the next year to verify the findings.

Effect of foliar application of zinc and manganese on the yield and quality of potato (*Solanum tuberosum* L.)

Foliar zinc and manganese were tested on the yield and quality of potato and to find out suitable foliar dose of zinc and manganese for potato at Breeder Seed Production Centre (BSPC), Debiganj, Panchagarh under AEZ-3 (Tista Meander Floodplain Soil) during the Rabi season of 2019-20. The treatments comprised foliar application with four levels of Zn (0, 0.05, 0.10 and 0.15%) and four levels of Mn (0, 0.05, 0.10 and 0.15%). The experiment was laid out in a factorial randomized complete block design (RCBD) with three replications. The tuber yield of potato was significantly influenced by foliar application of different concentration of zinc and manganese. The highest tuber yield (40.5 t/ha) was obtained in Zn_2Mn_3 .The highest dry matter content of tuber (21.8 and 20.6% for Zn and Mn, respectively) was found in Zn_3 and Mn_3. The minimum scab infection (0.82 and 0.99% for Zn and Mn, respectively) was found in Zn_3 and Mn_3. The other parameters will be presented after receiving the lab analytical data.

Response of potato to phosphorous in Old Himalayan Piedmont Plain Soil

The effect of phosphorus was evaluated on the yield and quality of potato on P uptake and fertilizer P recovery at Non-calcareous Grey Floodplain soil of Debiganj. There were seven treatments - T_1 (0kg P/ha), T_2 (20 kg P/ha), T_3 (40 kg P/ha), T_4 (60 kgP/ha), T_5 (80kg P/ha), T_6 (100kg P/ha) and T_7 (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 different levels of phosphorus. The highest potato tuber yield (47.0 t ha^{-1}) was found in T_4. The crop response to fertilizer application was positive and quadratic in nature. From the quadratic response function, the optimum dose of P was recorded as 68.0 kg ha^{-1} for Debiganj. The highest dry matter content (21.6%) in potato tuber was recorded in T_4. There were no scab infection and cutworm infestation in the plots.

The other parameter will be incorporated after receiving the lab analytical report. This is the second year result and it will be continued to verify the findings.

Effect of potassium sulphate on the yield and quality of potato through controlling scab disease

Potassium sulphate was tested as a source of sulphur in controlling *Streptomyces scabies* in potato and to find out the suitable dose and source of sulphur for potato at Grey Terrace soil of Joydebpur and Non-calcareous Grey Floodplain soil of Debiganj. The popular potato variety BARI Alu-7 (Diamant) was evaluated under different levels of sulphur fertilizer from potassium sulphate. The five different levels of sulphur were: T_1 (0 kg S/ha), T_2 (15 kg S/ha), T_3 (30 kg S/ha), T_4 (45 kg S/ha) and T_5 (60 kg S/ha). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Different sulphur levels and locations showed significant effect on the yield of potato over locations. The highest tuber yield (46.6 t/ ha) was found in T_3 at Debiganj, which was followed by T_4 (43.4 t/ha) in the same location. T_3 showed the maximum dry matter content in potato tuber. The minimum scab infection and cutworm infestation were also recorded in T_3. T_3 was found to be suitable for storage under normal room temperature for a period of 90 to 120 days. The post-harvest properties of soil will be presented after receiving the lab analytical data. This is the second year findings and it needs to continue to verify the first year result.

Integrated nutrient management for Potato-Aroids-T. a*man* rice cropping pattern

Organic manure and chemical fertilizers were tested to develop a suitable fertilizer package for Potato-Aroids-T.aman cropping pattern and to increase crop productivity and sustain soil health under integrated nutrient in 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), T5 (125% RDF) and T6 (Farmer's practice, FP). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The potato, aquatic taro and rice grain yields were significantly influenced by the integrated nutrient management in Potato-Aroids-T.aman cropping pattern. The highest potato tuber, taro stolon and rice grain yields were found in T_3 (PM 3 t ha^{-1}+ rest nutrient from RDF) while the maximum taro rhizome yield was recorded in T4 (CD 6 t ha^{-1}+ rest nutrient from RDF). The lower scab infection and the minimum cutworm infestation were observed in T3 and T4. The highest gross margin (Tk. 976230 ha^{-1}) and MBCR (15.5) were found in T3 followed by T4. This is the second year findings and it will be continued to verify the result.

Effect of organic fertilizer *Tumama* on the yield and quality of potato in Grey Terrace Soil

Tumama, a high organic-inorganic fertilizer was tested to evaluate the effect of tumama on the yield and quality of potato and to investigate the post-harvest properties of soil in Grey Terrace Soil of Joydebpur. There were four treatments - T_1 (control, native nutrient), T_2 (Tumama 1966 kg/ha), T_3 (Cowdung 5000 kg/ha + Tumama 984 kg/ha) and T_4 (100% RDF). The experiment was laid out in a randomized complete block design (RCBD) with four replications. Yield of potato was significantly ($p \leq 0.05$) influenced by the different treatments. The highest potato tuber yield (36.4 t ha^{-1}) was found in T_4. The highest dry matter content (22.0%) was found in T_2 (100% tumama), which was closely followed by T_3 (0.50% CD + 0.50% tumama). The minimum cutworm infestation (1.20%) was noted in T_3 (cowdung + tumama). There no scab infection and cutworm infestation were recorded in the plots treatment. T_3 was found to be suitable for storage under normal room temperature for a period of 90 to 120 days. The other parameter will be incorporated after receiving the lab analytical report. This is the first year result and it will be continued to verify the findings.

Effect of irrigation on the growth, yield and quality of potato

An irrigation trial was conducted at Breeder seed Production Centre (BSPC), Debiganj, Panchagarh during the Rabi season of 2019-2020 to study the effect of irrigation on the growth, yield and quality of potato. There were five treatments comprising different levels of irrigation such as T_1 =Two irrigation (Emergence + Stolonization stages), T_2 (Emergence + Tuberization stages), T_3 Three irrigations (Emergence + Stolonization + Tuberization stages), T_4 (Emergence + Tuberization +Bulking stages) and T_5 Four irrigations (Emergence + Stolonization + Tuberization +Bulking stages). Three released potato varieties such as BARI Alu 7 (Diamat), BARI Alu 25 (Asterix) and BARI Alu40 (4.45W) were used, varieties. The experiment was laid out in split plot design with three replications. Yield attributes and yield were significantly influenced by the irrigation and variety. The highest potato tuber yield (51.10 t/ha) was found in T_3 ton/ha). The lowest scab infected tubers (1.44 t/ha and 2.84%, respectively) were recorded in T_3 while the maximum scab infection was noted in BARI Alu7 (4.43 t/ha and 8.67%, respectively) followed by BARI Alu40. The highest dry matter (20.58%) was recorded in BARI Alu7 which was closely followed by BARI Alu40 (20.11%). Among the treatments, three irrigations (Emergence + Stolonization + Tuberization stages) and BARI Alu 40 were found better yield. This is the first year result and the experiment will be continued to verify the findings.

Tuber crops disease management

Survey of major potato diseases of Bangladesh

A survey work was conducted to observe the incidence of potato diseases in northern area of Bangladesh. Late blight disease incidence was relatively high in Dinajpur, Panchagarh, Thakurgaon and lower in Rangpur, Kurigram, Nilphamary, Lalmonirhat and Gaibandha districts. Zebra chips disease was first recorded in 2019-2020 in Kurigram, Lalmonirhat and Debiganj. Black leg and bacterial wilt disease incidence was higher in early season of potato cultivation whereas lower in late season. Common scab, mosaic, stems rot, early blight, stem canker and black scurf, PVY found as less incidence of potato in Bangladesh.

Evaluation of Potato Varieties against Late Blight Disease by Detached Leaf Methods

The Detached Leaf Bioassay (DLBs) of *Phytophthora infestans* on BARI Alu-7, BARI Alu-46, BARI Alu-53, BARI Alu-77, BARI Alu-90 and BARI Alu-91 showed susceptible to late blight under laboratory condition.

Screening of Potato Varieties and Germplasm Against Late Blight at RARS, Burirhat, Rangpur under field condition

Field experiment was conducted to evaluate 38 (thirty eight) BARI released varieties potato 03 (three) germplasm and 02 (two) indigenous cultivars against late blight disease during 2015-2016, 2016-17, 2017-18, 2018-19 and 2019-20 cropping seasons under natural inoculum pressure in farmers' field at Khaturia, Domar, Nilphamari and RARS, Burirhat, Rangpur. None of the variety/germplasm/indigenous cultivar was found immune. Variety BARI Alu-90 (Alouette) and BARI Alu-91 (Carolus) found highly resistant in every cropping season. Variety BARI Alu-46 was highly resistant in all cropping season but in the last cropping season it was resistant against Late blight. Newly included germplasm viz. Twinner and Twister found highly resistant since 2018-19 cropping year. Rest two late blight resistant varieties like BARI Alu-53 and BARI Alu-77 were highly resistant in cropping seasons 2015-16 and 2016-17 but from 2017-18 cropping season showed moderate resistance. In 2019-20 cropping season, BARI Alu-77 was resistant against late blight and BARI Alu-53 was susceptible. BARI Alu-57 was always resistant or moderately resistant. Yield of BARI Alu-46, BARI Alu-53, BARI alu-57, BARI Alu-77, BARI Alu-90 (Alouette), BARI Alu-91 (Carolus), Twinner and Twister was 30.87 to 49.47 t ha^{-1} , 9.63 to 29.88 t ha^{-1} , 24.58 to 29.33 t ha^{-1} , 17.79 to 29.37 t ha^{-1} , 35.11 to 53.79 tha^{-1} and 31.23 to 38.50 t ha^{-1} , 36.43 to 38.09 t ha^{-1} and 30.58 to 33.56 t ha^{-1} respectively.

Effect of different fungicidal combinations in controlling late blight of potato at RARS, Burirhat, Rangpur

Effectiveness of thirteen different sole and combined fungicides were evaluated against late blight of potato at RARS, BARI, Burirhat, Rangpur in 2019-20 cropping season. Fungicides and fungicidal combinations significantly reduced late blight disease and increased tuber yield over control where no fungicide was used. Zampro DM

(Ametoctradin 30% + Dimethomorph 22.5%) was the best one for disease management and yield. The highest yield (42.30 t/ha) was harvested from Zampro DM followed by manually mixture of Micra 72 WP (Mancozeb 64% + Cymoxanil 8%) @ 2g + Indofil M 45 (Mancozeb 80%) @ 2g per liter.

Efficacy of new fungicides in controlling late blight of Potato at BSPC, Debiganj, Panchagarh and RARS, Burirhat, Rangpur

A total of 30 different new fungicides with 1 control and one positive control fungicide Acrobet MZ were tested against late blight disease of potato at the BSPC, Debiganj, Panchagarh during 2019-20. Results revealed that most of the tested fungicides reduced the disease significantly over control. Among the 30 fungicides the twelve, viz. 30, 185, 193, 194, 198, 200, 202, 298, 314, 321, 323 and 332 yielding (17.25 t/ha, 21.54 t/ha, 17.77 t/ha, 19.36 t/ha, 22.17 t/ha, 18.88 t/ha, 19.55 t/ha, 22.07 t/ha, 17.39 t/ha, 22.64 t/ha, 19.01 t/ha and 17.70 t/ha respectively) showed excellent performance in controlling late blight disease.The experiment also conducted at RARS, BARI, Burirhat, Rangpur during rabi season to evaluate 15 (fifteen) new fungicides against late blight of potato under natural inoculum pressure. Results revealed that coded 111 and 128 fungicides effectively controlled late blight disease of potato and yielded more than 30 t/ha.

Development of Cost-Effective Integrated Fertilizer Management Practice Utilizing Agricultural Waste Tobacco Dust

Use of tobacco dust (≥800 kg ha^{-1}) as organic fertilizer significantly increased total and marketable potato yield and decreased common scab disease (incidence and severity) over control (Only recommended chemical fertilizer used plot) and cow dung (5 t ha^{-1}) used plot. There was no significant difference among tobacco dust dose 1000, 1500, 2000, 25000 and 3000 kg ha^{-1} with recommended fertilizer dose (RCFD) in terms of tuber yield (39.88 to 43.65 t ha^{-1}) and common scab disease status (incidence: 3.18 to 5.70% and PDI: 0.74 to 1.28). But total and marketable potato yield sharply increased and common scab disease status decreased up to TD 2000 Kg ha^{-1} + RCFD. There was no significant difference among TD 2000 Kg ha^{-1} + RCFD, TD 2000 Kg ha^{-1} + (-10%) RC"NPKS", TD 2500 Kg ha^{-1} + RCFD, TD 2500 Kg ha^{-1} + (-10%) RC"NPKS", TD 2500 Kg ha^{-1} + (-20%) RC"NPKS", TD 3000 Kg ha^{-1} + RCFD, TD 3000 Kg ha^{-1} + (-10%) RC"NPKS", TD 3000 Kg ha^{-1} + (-20%) RC"NPKS"and TD 3000 Kg ha^{-1} + (-10%) RC"NPKS" for total and marketable potato yield and common scab disease status.

Effect of different organic matter for managing soil-borne diseases (common scab) and yield of potato

Seven different organic matter and their combination cow dung @ 5.0 t ha^{-1}, ash @ 5.0 t ha^{-1}, cow dung @ 2.50 t ha^{-1}+ ash @ 2.50 t ha^{-1}, Kazijaibosar @ 1.0 t ha^{-1}, Annapurna jaibosar @ 1.0 t ha^{-1}, mustard oil cake @ 0.50 t ha^{-1}, Farah jaibosar @ 1.0 t ha^{-1} and Tobacco dust @ 0.85 t ha^{-1}were tested for management of common scab disease and yield of potato during 2019-20 cropping season at RARS, Burirhat, Rangpur. Lower disease incidence (10.20 to 11.56%), disease severity (2.14 to 2.79), higher marketable tuber yield (35.01 to 40.75 t ha^{-1}) and total yield (43.86 to 48.42 t ha^{-1}) was in Annapurna jaibosar @ 1.0 t ha^{-1}, Mustard oil cake @ 0.50 t ha^{-1}, Farah jaibosar @ 1.0 t ha^{-1} and and Tobacco dust @ 0.85 t ha^{-1}incorporated treatment. Out of all, Tobacco dust @ 0.85 t ha^{-1} was the best one for disease control as well as highest potato tuber yield.

Validation trial of seed and soil treatments in controlling common scab disease of potato at Gazipur

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 nine (09) treatments were selected as different combinations of seed and soil treatments. The treatment T_9 means straw burn before seed sowing into the soil found to be more effective to control common scab based on disease the incidence and severity.

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

Six 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 2019-20 under the field condition. Considering scab incidence and severity BARI Alu-38, BARI Alu-73, BARI Alu-79 and BARI Alu-78 performed better showing lower common scab in potato.

Screening of potato varieties against common scab at RARS, Burirhat, Rangpur

There were thirty three potato varieties and three germplasm were evaluated since 2015-16 to 2019-20 against common scab disease under natural inoculum pressure and artificially inoculated condition at farmers' field, Khaturia, Domar, Nilphamariand RARS, Burirhat, Rangpur. There were no varieties / germplasm was found immune against *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 exhibited good level of resistance/tolerance against common scab in known infested soil under natural condition. Disease incidence and severity (PDI) range was 0.58 to 8.46% and 0.11 to 1.74 respectively. But in artificial inoculated condition, disease incidence and severity (PDI) range was 29.67 to 72.09% and 6.60 to 17.76 of those varieties. The least common scab incidence (5.05%) and severity (PDI-1.01) were recorded in germplasm Twinner in artificial inoculated condition. BARI Alu-73, BARI Alu-78, BARI Alu-79, BARI Alu-81, BARI Alu-73 showed good level of tolerance in known common scab infested soil under natural condition. BARI Alu-90, BARI ALu-91 and germplasm Twister were also good in both artificial inoculated common scab soil and natural condition.

Evaluation of Potato lines for PLRV and PVY resistance under the infection pressure (Second Progeny)

Eighteen potato lines were evaluated against PLRV and PVY to find out the resistant source (s) at Joydebpur, Gazipur during 2019-20. All lines including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in the cropping season of 2018-19 at Joydebpur. Data were taken on percent PLRV, PVY, mixed virus incidence, germination, vigour and yield. In growing on test during 2019-20, both PLRV and PVY infection was varied significantly among the tested lines. Based on all parameters, the lines 15.115, 15.35 and Prada performed better compared to other tested lines. The experiment will be repeated in the next year.

Evaluation of potato lines for PLRV and PVY resistance under the infection pressure (Third Progeny)

Nineteen potato lines were evaluated against PLRV and PVY to find out resistant source (s) at Joydebpur, Gazipur. All lines including a check variety Diamant were exposed to the infection pressure of PLRV and PVY in the cropping season of 2017-18 at Joydebpur. Data were recorded on percent germination, PLRV, PVY, mixed virus, yield and plant vigour. Based on all parameter, the lines 14.10, 14.11 and Ottawa were found as better showing free infection to PLRV, PVY and other mixed virus.

Detection of Potato viruses (PLRV, PVY, PVX, PVM and PVS) in the supplied samples of different companies through DAS-ELISA

A total of 933 plantlet samples from different government and non-government organizations were tested for the presence of viruses by using specific DAS-ELISA detection separate kits as PLRV, PVY, PVX, PVS and PVM according to manufacturer’s instructions (Bioreba AG, Switzerland). Out of 933 samples, 755 had completely virus free and 178 had infected with different alone and combine viruses. Among virus infected samples, none had PLRV and PVM. The highest number of virus was PVX followed by mixed viruses, PVY, PVS and PVM.

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

A total of twelve (12) potato varieties were assessed for post harvest rottage and shelf life at Joydebpur under natural storage conditions. The percentage of tuber rot due to disease was increased with the increase of time. Considering overall performance, BARI Alu -7, BARI Alu-8, BARI Alu -13, BARI Alu -25, BARI Alu -35, BARI Alu -36, BARI Alu-37, BARI Alu -40, BARI Alu -41, BARI Alu -46, BARI Alu -53 and BARI Alu -72 found to be better for 90 days of preservation, but up to 180 days only BARI Alu-8 and BARI Alu-37 preserved for longer shelf life under natural storage condition up to 180 days.

Tuber crops insect management

Development of management approaches against root aphid (*Pemphigus* sp.) attacking potato

A field trial was conducted at the farmer's field of Gonomongal, Khetlal, Joypurhat during 2019-20 to find out the most effective management option for root aphid on potato. There were six treatments viz. T_1 = Clean cultivation (Destroy weed + proper irrigation to prevent cracking, cracks provide a way for aphid to enter the soil), $T_2 = T_1$ + 2 sprays of Matrin (Biotrine 0.5%) @ 1.4ml/L of water from initial stage of infestation at 10 days interval, $T_3 = T_1$ + 2 sprays of Nitro (Chlorpyrifos + Cypermethrin) @ 2ml/L of water from initial stage of infestation at 10 days interval, $T_4 = T_1$ + 2 sprays of Thiamethoxam @ 0.5g/L of water from initial stage of infestation at 10 days interval, $T_5 = T_1$ + 2 sprays of Imidacloprid @ 0.5ml/L of water from initial stage of infestation at 10 days interval and T_6= Untreated control. The lowest infestation was found in T_4 which was which was statistically similar with $T_{5.}$ In case of Marginal Benefit Cost Ratio, the highest value was also obtained from T_4 which was close to T_5.

Evaluation of released potato varieties and advanced materials against potato cutwrom (*Agrotis ipsilon*) in field condition

Twenty two advanced materials namely 12.13, 12.20, 13.7, 13.17, 13.19, Actrice, Alberta, Alrusset, Arigone, Cerega, Carolus, Fortus, Fontain, Margarita, Ottawa, Picobella, SunRed, Innovator, Sayada, Tiamo, Messi along with four released varieties namely Diamant, Cardinal, Asterix and Lady Rosetta were evaluated against cutworm at Tuber Crops Research Sub Centre, BARI, Bogura during 2019-20. All the genotype showed better performance against cutworm. Very little infestation (0.16-3.52% by no and 0.26-4.63% by wt) was observed in the study.

Development of effective integrated management package against sweet potato weevil in field condition

The trial was conducted at Tuber Crops Research Sub Centre, BARI, Bogura during 2019-20 to develop an effective intrgrated management approach for sweet potato weevil in field condition. There were four treatments viz. T_1: Pheromone trap + Earthing-up three times (30, 60 and 90 DAP), T_2: Pheromone trap + Soil Recharge @ 3g/L of water at 45 days and 90 days afterplanting, $T_{3:}$ Farmer's practice (Carbofuran 5G (Furadan 5G)) @ 15kg/ha at 60 days and 90 days afterplanting with irrigation, T_4: Untreated control. The lowest infestation and highest yield was obtained from the treatment T_2 which was statistically similar with $T_{1.}$ Huge number of moth was trapped in pheromone traps. Number of captured weevil/trap/week was 34.57 in T_1 and T_2 which reduced the infestation.

Integrated management of cutworm (*Agrotis ipsilon*) in potato

The field trial was conducted at Tuber Crops Research Sub Centre, BARI, Bogura during 2019-20 to find out the most effective management option for cutworm on potato. There were six treatments viz. T_1= Poison bait: (Rice husk 5kg + sugar 200g + Cartap + water) (Three times at 15 days interval starting from after emergence of the seedling), T_2= Carbofuran @ 15 kg/ha application during land preparation and earthing up, T_3=Sex pheromone mass trapping, $T_4= T_1+ T_3$, $T_5= T_2+ T_3$ and T_6= Untreated control. Very little infestation (less than 1%) was observed in the study. Infestation did not varied significantly.Tthe experiment may be repeated in the next year for conclusion.

Field efficacy of attract and kiil method against potato tuber moth under field condition

The experiment was conducted at Tuber Crops Research Sub Centre, Bogura, Munshiganj and Breeder Seed production Centre, Debiganj, Panchgarh during rabi, 2019-20. There were two treatments viz. T_1 = Pheromone mass trapping for potato tuber moth and T_2 = Pheromone mass trapping for potato tuber moth with attract and kill method. No damage symptom was observed in the field and no moth was captured in both Pheromone trap and attracts and kills method.

Survey and monitoring of new pest arthropods infesting tuber crops

Survey and monitoring was conducted at different tuber crops growing areas during 2019-20 to document new pest arthropods infesting tuber crops. Three new insect pest were found to attack, among them severe infestation of *Spodopteralitura* was observed in Hybridization block of potato at Breeder Seed Production Centre, Debiganj, Panchgarh.

Screening of different sweet potato varieties/lines against sweet potato weevil *(Cylas formicarius* fab.*)*

Fifteen advanced materials along with two checks of sweet potato were evaluated against sweet potato weevil at Tuber Crops Research Sub Centre, Bogura during 2019-20. Among the genotypes, White flesh White skin, $H_{9.13/11}$, $H_{9.7/12}$ and $H_{6.13/11}$ showed comparatively less infestation (0.5%-5.57%) than other advanced materials/varieties.

Survey, monitoring and documentation of major insect pests of mukhikachu

A field survey was conducted in Bogura during 2019-20 to document the insect and mite pests of mukikachu. Several insect-mite pests viz. Common cutworm (*Spodopteralitura*), spittle bug and red mite were found to attack the crop. Although the pests are occational, but sometimes common cutworm and red mite caused serious damage.

Studies on succession of insect-mite pests on yam

The trial was conducted at Tuber Crops Research Sub Centre, BARI, Bogura during 2019-20 to observe the succession of the insect-mite pests of yam and their damage severity. Result revealed that 4 species of insect pests i.e. leaf roller, June beetle, hairy caterpillar and Tussok moth were found to attack the crop. All the pests were appeared at vegetative stage and caused minor damage.

Studies on succession of insect-mite pests on cassava

The trial was conducted at Tuber Crops Research Sub Centre, BARI, Bogura during 2018-19 to observe the succession of the insect-mite pests of cassava and their damage severity. Only mealy bug were found to attack the crop at vegetative stage and caused minor damage.

Post-harvest technology

STORAGE

Storage behaviour of potato varieties and hybrid clones under natural condition

An experiment was conducted during March to August 2019. Tubers of exotic potato varieties and clonal hybrids of RYT, AYT and SYT were evaluated for storage behaviour under natural condition. 12.13, 12.2 with other like Colombus, CIP 225 under exotic varieties of RYT performed better storage performance in natural condition. In case of exotic varieties of AYT, Actrico was the best performer. Regarding AYT, 13.7, 13.19 and 13.17 the clonal hybrids of showed good storage performance. Regarding secondary yield trial (SYT), the exotic varieties of Sayada (9.80%), Tiamo (6.21%), Primevera (3.90%) showed good performance. In secondary yield trial (SYT) hybrid clones all were good performers except 14.44.

Effect of different natural storage conditions on keeping quality of potato at munshiganj

An experiment was conducted at Sadar, Munshigonj to find out the suitable natural storage conditions and to minimize post-harvest losses of potato at farmers' field immediate after harvesting. This experiment was executed by Tuber Crops Research Sub-Centre, Munshiganj during 2019-2020 with six natural storage conditions viz. straw, dried water hyacinth, dried potato herbs, straw with shade, dried water hyacinth with shade and dried potato herbs with shade with a view to observe the performance of these natural storage conditions in regards to weight loss and potato quality. The natural storage condition like straw with shade and dried potato herbs with shade performed better considering the total loss percentage for all 30, 60 and 90 days after storage (DAS) while the worst performance was observed in case of dried water hyacinth in all dates.

Processing

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

Six exotic varieties of SYT were studied for their processing quality in the form of Chips and French Fries. Alcander and Delia Red varieties showed better performance in chips and French fries while

Prada showed excellent performance in French fries. Eight hybrid clones under SYT were also evaluated and 15.8 and 15.139 produced better quality chips and 15.92 performed better for both chips and French fries. 13.17 and 13.19 out of 3 clones exhibited better performance in case of chips at RYT level. Among the exotic materials at RYT Messi and Picabella produced excellent chips and french fries. Ten exotic varieties under AYT were evaluated and Alberta, Fontane and Dunstar showed better performance in chips and French fries. Among the hybrid materials for AYT, 14.11 and 14.31 showed better performance for chips and 14.11 were good in both cases – chips and French fries.

Technology transfer

Adaptive trials with newly released potato varieties

Adaptive trials with new potato potato varieties were conducted at thirty two districts to promote as well as to know the farmers acceptance about the new potato varieties with the partial financial support of KGF. All the tested varieties varied between and within location. The average highest yield over the location 36.59 t/ha was recorded in BARI Alu-41 followed BARI Alu-40 (35.64 t/ha) and BARI Alu-37 (33.94 t/ha). BARI Alu-35 was the lowest yielder (32.22 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 (heat& salt tolerant) Potato variety at farmers' field

Promotion and dissemination trials with climate smart new potato varieties were conducted at eight districts to promote as well as to know the farmers acceptance about the new potato varieties with the partial financial support of KGF. In each district the trial was replicated 5-15 locations. The tested two varieties varied between and within location. Average yield over the location of BARI Alu-72 was 27.62 t/ha and BARI Alu-73 was 23.93 t/ha. The highest yield of BARI Alu-72 was observed in Barishal and of BARI Alu-73 was found in Koyra, Khulna where as lowest yield was in Patuakhali for both the variety BARI Alu-72 and of BARI Alu-73.Framers reaction varied between the locations. Both 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 late blight resistant potato varieties

Forty seven field trials were conducted on BARI released late blight resistant potato varieties viz. BARI Alu-46 and BARI Alu-53 at farmers' field of eight late blight disease prone districts in Bangladesh (Bogura, Panchagarh,Debigonj Gaibandha, Rangpur, Nilphamari, Lalmonirhat, Joypurhat, Rajshahi and Kurigram) during 2019-20 for promotion and dissemination with the partial financial support of KGF. Yield of BARI Alu-46 and BARI alu-53 ranged 27.88 to 42.06t/ha and 26.17 to 43.16 t/ha, respectively. Incidence of common scab, virus and late blight were found very low compared to farmers' adjacent plots. Farmers were very happy to observe the performance of the varieties as late blight resistance and yield

Adaptive trial of newly released potato varieties through potato seed producing private company and NGO

Adaptive trials with new potato varieties BARI Alu-47, BARI Alu-48, BARI Alu-49, BARI Alu-50, BARI Alu-62, BARI Alu-63, BARI Alu-73, BARI Alu-78, BARI Alu-79, BARI Alu-81were conducted at five seed producing company and NGO to promote as well as to know the company/NGO acceptance about the new potato varieties with the partial financial support of KGF. The main objectives were how to incorporate new potato varieties in their seed production system. This was the first year trials for this set. Considering the present results some company/NGO showed their interest about tested varieties. Their demand is timely supply of breeder seed of the tested new varieties.

02 PULSE CROPS

Blackgram

Varietal Improvement

Hybridization and advancement of generations

Hybridization of blackgram was conducted for creating genetic variability with desired gene combinations within the existing germplasm during Kharif-II season, 2019 at Pulses Research Centre, Ishurdi, Pabna. Six parents with desired characters *viz.* BBLX-08008-2-1, RU 122, 9020, BBLX-02005-1, Thakuri and BARI Mash-4 were used and a total of 357 successful crossed seeds were collected from fifteen cross combinations that will be sown during the next season. Fifteen F_1s obtained from Kharif-II, 2018 were grown along with their parents at Pulses Research Centre, Ishurdi, Pabna during Kharif II, 2019 and on the basis of morphological characters fifteen accessions were selected as confirmed cross. Eleven F_2 segregates were grown along with one check BARI Mash-3 to advance the generation during Kharif-II, 2019 where a total of 35 single plants from eleven F_2s were selected and harvested separately. Eight F_3s were grown along with check to advance the generation during Kharif-II, 2019. 6-20 plants from different cross combinations were selected and harvested separately which will be grown in the next Kharif-II season. A total of 123 single plants were selected from eight F_4s generation comparing with check variety BARI Mash-3 based on desired phenotypic characters for advancement the generation from F_4 to F_5.

Preliminary yield trial of blackgram

The trial was carried out to determine the performance of eight blackgram genotypes for yield and yield contributing characters at Ishurdi, Pabna; Gazipur and Madaripur. The genotypes were BBLXK$_2$ 12002-11, BBLXK$_2$ 12002-2, BBLXK$_2$ 12002-4, BBLXK$_2$ 12002-7, BBLXK$_2$ 12003-9, BBLXK$_2$ 12005-5, BBLXK$_2$ 12005-6 and BARI Mash-4 as a check. In case of days to flowering and days to maturity over three locations, no genotype performed earlier than check variety BARI Mash-4, but all genotypes flowered early at Gazipur location and mature early at Madaripur location. Among the all genotypes, BARI Mash-4 was bold seeded. The highest mean seed yield was recorded in BBLXK2 12005-5 (1414 kg/ha), BBLXK2 12005-6 (1268 kg/ha), followed by BBLXK2 12002-4 (1246 kg/ha), BBLXK2 12002-2(1242 kg/ha) and BARI Mash-3 (1226 kg/ha. Therefore, four genotypes BBLXK2 12005-5, BBLXK2 12005-6, BBLXK2 12002-4, BBLXK2 12002-2 were selected for further evaluation.

Participatory variety selection of blackgram

The trial was conducted as a farmer's field trial at Ishurdi, Manikgonj and Madaripur during Kharif-II season of 2019. Four blackgram genotypes *viz.* BG-2, BG-4, BG-7 with one check (BARI Mash-3) were evaluated. The highest yield was found in BG-2 (1348 kg/ha) followed by BG-7 (1257 kg/ha), BG-4 (1231 kg/ha). From this trial genotypes BG-2, BG-7and BG-4 were selected for further evaluation.

Productivity of blackgram as influenced by integrated application of phosphorus and zinc under rainfed condition

The experiment was conducted at the research field of Pulses Research Centre, Ishurdi, Pabna during 2019-20 to find out optimum rates of phosphorus and Zink for growth and yield of blackgram. The experiment was laid out in RCB Design with three replications. The trial consisted of nine nutrient treatments such as such as $T_1= P_0Zn_0$;$T_2= P_0Zn_2$; $T_3= P_0Zn_4$;$T_4= P_{20}Zn_0$;$T_5=P_{20}Zn_2$; $T_6= P_{20}Zn_4$;$T_7= P_{40}Zn_0$;$T_8= P_{40}Zn_2$;and $T_9= P_{40}Zn_4$.The experiment was designed randomized complete block with three replications. The unit plot size was 4m×3m. Nutrients P and Zn was supplied from TSP and Zinc sulphate.No significant difference was observed in pod length and seed/pod among the treatment which, respectively ranged from 4.4 - 4.39 cm and 5.73-6.33. The highest seed yield was recorded in yield T_5 and by T_9 (1279 kg/ha) T_7 (1288 kg/ha) and control (T_1) produced the least (827 kg/ha). No significant variation was observed in stover yield among the treatment. Application of P and Zn might influence the yield of blackgram to achieve higher yield without any statistical significance. From the results, it was obvious that application of B @ 2 and P 20 kg ha^{-1} increased the yield substantially over the control treatment (T_1).

Chickpea

Varietal Improvement

Hybridization and advancement of generations

Hybridization of chickpea was undertaken for creation of genetic variability with desired gene combinations at PRC, Ishurdi, Pabna during rabi 2019-20. Six parents *viz.* BCX 08009-9, ICCV-07102, BCX 09010-9, ICCV 171306, BARI Chola-11and BARI Chola-4 were used followed by half-diallel fashion and a total of 118 successful crossed derived seeds were harvested separately from fourteen cross combinations. Fifteen cross combinations were grown along with their male and female parents in both sides during rabi season 2019-20 at PRC, Ishurdi, Pabna from which a total of 60 individual F_1s plants have been confirmed and harvested separately from 15 combinations. Eight F_2s were grown along with BARI Chola-5 and BARI Chola-10 as a check variety for comparing with the F_2 segregates at Pulses Research Centre, Ishurdi, Pabna during rabi 2019-20 and the total population was bulked for retention of more variabilty as F_3s generation in the next season. Ten F_3s progenies and eight F_4s progenies were evaluated and their seeds were bulked during rabi 2019-20. Three F_5 progenies selected in the last year were grown along with the check variety BARI Chola-5 and BARI Chola-10 during rabi 2019-20 at Pulses Research Centre, Ishurdi, Pabna from which forteen lines were selected which will be grown in the next year at observation trial.

Regional yield trial of chickpea

The trial was carried out to evaluate the performance of five chickpea genotypes along with check BARI Chola-5 and BARI Chola-10 for yield and yield related traits in five locations during Rabi 2019-20. Considering mean data for days to flower the genotype BCX 13004-4 followed by BARI Chola-10 flowered earlier. From the mean data across location the mean highest pod per plant recorded from BARI Chola-10 followed by BCX 13002-2 and the lowest from genotype BCX 13005-8. The genotype BCX 13004-4 gave the highest mean seed yield (1357 kg/ha) followed by BCX 13002-2 across the locations where as the genotype BCX 13004-4 was also found more stable across the locations. Considering duration, stability parameters, yield traits and yield performance, two entries BCX 13002-2 and BCX 13004-4were selected to evaluate in the next Rabi season under PVS trial.

Evaluation of Chickpea Exotic Germplasm

The experiment was conducted for evaluation and seed multiplication of chickpea exotic germplasm during 2019-20 at PRC, Ishurdi, Pabna. A total of 44 genotypes along with one check BARI Chola-10 was evaluated. Variability was found in all the parameters of data. Finally, 21 genotypes were selected for further evaluation in replicated trial in the next season.

Performance of Chickpea Genotypes under Optimum and Late Sown Condition

The experiment was carried out at PRC, Ishurdi and RARS, Jashore to evaluate 11 chickpea genotypes under late sown condition. High temperature or heat was imposed by delaying sowing dates i.e. normal (22th-25th November) and late sowing (22th-25th December). Chickpea genotypes were assessed based on various yield contributing traits and yield. However, there was significant interaction of date of sowing with genotypes. The genotypes suffered from reduced growth and yield due to heat exposure under late sown condition.

Pods per plant and plant height also abruptly reduced in tested genotypes in the 2nd date of sowing. On an average 460 kg/ha to 745 kg/ha yield reduced in the 2nd date of sowing. All the entries showed 3-16 days earlier in maturity in second date of sowing due to forced maturity. The entry ICCV 07102 and BARI Chola-10 performs better in late sown condition in both the locations.

Growth and yield performance of BARI Chola-10 as influenced by nipping practices at different growth stages

The experiment was conducted at Regional Agricultural Research Station, Jashore field during Rabi 2019-20 to investigate the growth and yield performance of BARI Chola-10 as influenced by nipping practices at different growth stages. The experiment was conducted in split-plot design with three replications. There were two factors in this experiment Factor A: Various growth phases of nipping (03), i) E1= 30 days after emergence ii) E2= 40 days after emergence iii) E3= 50 days after emergence, Factor B: Different heights of nipping practices (04): T1= Control, T2= Nipping 5 cm from growing tip, T3= Nipping 8 cm from growing tip, T4= Nipping 10 cm from growing tip. Factor A was allocated in main-plots and factor B was be allocated in sub plots. The highest produced (1453.9 kg/ha) was produced by E3T2 (nipping 05 cm from growing tip after 50 days of sowing) followed by E2T2 (nipping 05 cm from growing tip after 40 days of sowing), E2T4 (nipping 10 cm from growing tip after 40 days of sowing) and E2T3 (nipping 08 cm from growing tip after 40 days of sowing) interaction, respectively. On the other hand the grain yield lowest (582.6 kg/ha) was found from E1T1 (control) interaction. The highest amount of vegetable yield (763.03 kg/ha) was recorded from E3T4 (nipping at 10 cm from tip after 50 days of sowing) interaction. The highest total gross return (125392.2 tk/ha) and highest gross margin (97792 tk/ha) was found in E3T2 (nipping at 05 cm from tip after 50 days of sowing) interaction effect. The highest BCR (4.54) and lowest (1.7) was recorded by E3T2 (nipping at 05 cm from tip after 50 days of sowing) and E1T1 (control) interaction effect, respectively.

Cowpea

Varietal Improvement

Adaptive Trial of Cowpea Genotypes

An adaptive trail was implemented at RARS, Rahmatpur, Barishal during Rabi season of 2019-20 to evaluate the adaptive quality of eight selected cowpea germplasm with one check variety in southern agro-climatic conditions. Eight selected cowpea germplasm *viz.*CPL-1-17, CPL-2-17, CPL-3-17, CPL-3-17, CPL-4-17, CPL-5-17, CPL-6-17, CPL-7-17, CPL-8-17 including one check variety BARI Felon 1 were evaluated in the trial. Results showed that all the characters under this study were significantly different among the genotypes except plant population/plot, plant height and hundred seeds weight. The germplasm CPL-7-17 was produced the maximums seed yield (1761.7 kg/ha) which was statistically identical with CPL-8-17 (1621.2 kg/ha) and CPL-2-17 (1603.7 kg/ha) whereas, the lowest seed yield can be observed CPL-5-17 and CPL-1-17 (587 kg/ha and 618.9 kg/ha, respectively).

Effects of different management practices on yield and yield attributes of cowpea

A field study was carried out at Regional Agricultural Research Station, Rahmatpur, Barishal to study the effect of different management practices on yield and yield attributes of cowpea during Rabi 2019-20.*The* experiment was carried out with seven different management options e.g. i) Insecticide spray (2 times) (ii) Chemical fertilizer + insecticide spray (2 times) (iii) Weeding (3 times) + Chemical fertilizer (iv) Chemical fertilizer + weeding (3 times) + insecticide spray (2 times) (v) Weeding (3 times) (vi) Weeding (3 times) + insecticide spray (2 times) (vii) Chemical fertilizer viii) control under randomized complete block design with three replications . BARI Felon-1 was used as the variety. The results revealed that, combination of chemical fertilizer + weeding (3 times) + insecticide spray (2 times) management practice gave the highest seed yield (1548.9 kg/ha) considering yield and yield contributing characters although exhibited comparatively lower BCR (1.9). Chemical fertilizer + insecticide spray (2 times) and weeding (3 times) + insecticide spray (2 times) also gave statistically identical yield. Considering, economic analysis the treatment insecticide spray (2 times) gave higher BCR (5.9) and significant seed yield (1110.6 kg/ha).

Adaptive trial of cowpea genotypes in southern region

The field trial was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during Rabi season of 2019-20 to find out the suitable genotype(s) of cowpea for better adaptation as well as higher yield. Five entries of cowpea viz., E_1 = CPS-6, E_2 = CPS-12, E_3 = CPS-14, E_4 = CPS-15 and E_5 = BARI Felon-1 (check variety) were tested in this experiment. The genotypes differed significantly in terms of plant height, number of pod/plant, pod length, number of seed/pod, and seed yield. Plant height became the highest (86.65 cm) in CPS-12 which was partially identical to that of CPS-6 (73.70 cm) and CPS-15 (60.70 cm). The genotype CPS-15 produced the highest number of pod/plant (12.88) that was partially at par to that of CPS-12 (10.14) and CPS-6 (10.12). The pod length showed the highest value (24.27 cm) in CPS-12, which was statistically similar to that of CPS-15 (23.05 cm), CPS-6 (21.79 cm) and CPS-14 (21.09 cm). The genotype CPS-6 gave the highest number of seed/pod (13.95) followed by CPS-12 (13.43) but the lowest number of seed/pod (9.73) was obtained from BARI Felon-1. The highest yield of seed (1325 kg/ha) was found in CPS-15, which was partially identical to that of CPS-6 (1220 kg/ha), CPS-12 (1210 kg/ha) and BARI Felon-1 (1100 kg/ha). Results further indicated that CPS-15 increased the seed yield 20.47% over the check variety (BARI Felon-1). Besides, the genotypes CPS-6 and CPS-12 gave 10.93% and 9.94% more yield than that of BARI Felon-1. On the other hand, CPS-14 produced 8.43% less yield over the check variety. Therefore, CPS-15 and CPS-6 are promising entry/lines for releasing as new varieties.

Effect of different mulch materials on soil salinity and yield of cowpea

This trial was carried out at the farmer's field of Kuakata, Kalapara, Patuakhali during rabi season of 2019-2020. In the saline area, soil moisture is rapidly lost during the late Rabi season which is a critical problem for producing winter crops. We wanted to find out an effective ways to retain moisture in the soil by the use of mulching materials in winter cowpea production. Surface mulch has significant effect in reducing evaporation and decreasing soil salinity level. The aim of the study was to compare the effect of different mulch materials on cowpea seed yield. Different mulch materials such as i) no mulch (T_1), ii) straw mulch (T_2), iii) rice husk mulch (T_3) and iv) polythene mulch were tasted under randomized complete block design with three replications. BARI Felon-1 was used as the variety. Results revealed that, rice husk mulch (1740kg ha^{-1}) significantly increased seed yield of cowpea whereas 1500 kg ha^{-1} was from Control. The highest BCR can be found from straw mulch treatment (1.24).

Fababean

Varietal Improvement

Evaluation of Fababean Exotic Germplasm

Eighty-nine exotic germplasm of fababean along with local cultivar kalimotor were evaluated at Pulse Research Sub-Station, Gazipur during Rabi 2019-2020 for yield and yield contributing characters. Results showed that all the characters under study were significantly different among the genotypes. There were significant variations among all the genotypes. The covariance matrix gave non hierarchical clustering among 89 fababean genotypes and grouped them into ten clusters. Cluster IX contain the largest number (15) of genotypes followed by cluster and X (14). The cluster I and VIII each included four genotypes. The genotypes accumulated in the same cluster are not sharply diversified. Number of pods plant^{-1} varied from 6.0-12.0. The maximum number pods plant^{-1} (12.0) was obtained from 11NF0086-14, 11NF005e-6 followed by 11NF008b-15 and 11NF014a-12 and the lowest (6.0) in 11NF014-16, 11NF020a-4. Number of seeds pod^{-1} varied from 1.8-3.4. Maximum number of seeds pod^{-1} (3.4) was recorded from 11NF020b-4 and minimum (1.8) from 11NF0101-2. 100 seeds wt. ranged from 49.3-32.7g. The results revealed that 11NF014b-16 genotype gave the highest seed yield followed by 11NF008b-15 and the lowest yield was obtained from genotype 11NF011b-7.

Fieldpea

Varietal Improvement

Advancement of fillial generations in fieldpea

The advancement of F_1 to F_5 generations was conducted at PRC, Ishurdi, Pabna during Rabi 2019-20. Seven, ten, and ten populations and twenty five families were selected from F_1, F_3, F_4 and F_5, respectively to advance the generations.

Evaluation of fieldpea genotypes

An experiment with seven genotypes and two checks was conducted at Pulses Research Centre, Ishurdi, Pabna and RPRS, Madaripur during Rabi 2019-20 to find out suitable and high yielding genotypes/variety of fieldpea. Results revealed that all the yield contributing characters under study were significantly different among the genotypes. The mean yield of the tested genotypes varied from 1172 -1788 kg/ha but none of the tested entries was out yielded the check BARI Motor-3. The experiment will be repeated in the next year in both the locations for further confirmation.

Participatory varietal selection of fieldpea

The experiment was carried out to evaluate the performance of yield and yield related traits of two fieldpea genotypes along with check BARI Motor-1 and BARI Motor-3 at farmers' field during Rabi 2019-20. From the mean data across location BARI Motor-1 gave the highest pods per plant but the genotype BFP 11017 exhibited the highest mean seed yield. Considering earliness, higher yield, stability parameter and farmers' preference BFP 11017 has been selected to release as a variety.

Effects of seed rate on yield and yield attributes of grasspea under relay condition

A field experiment was conducted at PRC, BARI, Ishwardi during rabi season 2019-20 to find out the optimum seed rate for newly released field pea variety (BARI Khasari-3) for better crop growth and yield. The experiment was conducted in randomized complete block design with three replications. There were four seed rates *i.e.*,40 kg/ha, 50 kg/ha, 60 kg/ha and 70 kg/ha. It was observed that seed rates 70 kg/ha increased plant population, seeds/pod and grain yield. Seed rate @ 70 kg/ha performed better for newly released Grasspea variety, BARI Khesari 5. However, this experiment will be continued for the next year for concrete conclusion.

Effects of seeding method and seed rate on yield and yield attributes of field pea

A field experiment was conducted at PRSS, BARI, Gazipur during rabi season, 2019-20 to find out the sowing method and optimum seed rate for newly released field pea variety (BARI Motor-3) for better crop growth and yield. The experiment was conducted in randomized complete block design with three replications. There were three sowing methods- line sowing at 40 cm and 50 cm, and broadcast sowing; and three seed rates *i.e.*,70 kg/ha, 80 kg/ha and 90 kg/ha. It was observed that between line and broadcast sowing there was no significant difference. Among the seeding methods line sowing with 40 cm gave better yield and yield attributes over other treatments. Comparing with seed rates 90 kg/ha increased plant population seeds/pod and grain yield. Seed rile @ 90 kg/ha X like sowing @ 40 cm performed better for of newly released field pea variety BARI Motor-3. However, this experiment will be continued for the next year for concrete conclusion.

Effects of seeding time on yield and yield component of a promising pea genotypes (BP001)

A field study was carried out at PRSS, BARI, Gazipur during rabi season of 2019-20 to find out the optimum sowing time for higher growth and yield of pea genotypes (BP001).*The experiment* was carried out with seven different sowing time e.g. i) 15 November; ii) 20 November; iii) 25 November; iv) 30 November; v) 05 December; vi) 10 December; vii) 15 December under randomized complete block design with three replications. The results revealed that the yield was higher in 15 November (2722 kg/ha) followed by 20 November and lower in 15 December (556 kg/ha).

Performance of different varieties/genotypes of pea as affected by shoot picking for vegetable and grain production

A field experiment was conducted at Pulses Research Sub-Station, Joydebpur, Gazipur during rabi season of 2019-20 to find out the suitable adapt variety for the higher production of vegetable, grain and economic net return. The experiment was conducted in randomized complete block design with three replications. Three varieties such as BARI Motor-1, BARI Motor-2, BARI Motor-3 and two promising line such as promising line-1 and promising line-2 were compared to identify the suitable adapt variety for the higher production of vegetable, grain and economic net return. The tallest plant was found in BARI Motor-3 while the dwarf plant was found in promising line-2. The highest grain yield was found from promising line-2 while the lowest grain yield was found from BARI Motor-3. In case of vegetable yield, the highest vegetable yield was obtained from BARI Motor-3. However, this experiment will be continued in the next year for concrete conclusion.

Performance of different field pea varieties/ germplasm relaying with T. Aman rice

A field experiment was conducted at Pulses Research Centre and Regional Agricultural Research Station, Ishurdi during rabi season of 2018-19 and 2019-2020 to find out the suitable cultivars on the growth and yield of field pea under relay condition. The experiment was conducted in randomized complete block design with three replications. There were six cultivars, e.g. BFP 11016, Bagha local, BARI Motor-1, BARI Motor-3, Jikorgacha local and Sikim local. Among the field pea cultivars, the highest seed yield was obtained from Bagha local (1.1 t/ha) followed by BARI Motor-3 (1.0 t/ha) while the lowest seed yield (0.4 t/ha) was obtained from BFP 11016 in 2018-19. In 2019-20, the highest yield was obtained from BARI Motor-3 which might be attributed to higher number of pods/plant. However, this was the second year trial and will be continued for the next two years for concrete conclusion.

On-farm relay sowing package of pea for green pod in Barishal district

An on farm trial was conducted on relay sowing package of field pea in Babuganj and Wazirpur upazilla of Barishal for green pod production during Rabi season of 2019-20. Pulses Research Center, BARI has developed relay sowing package of field pea with T.aman rice which was practiced at farmer’s level. The relay sowing package included improved variety e.g. BARI Motor- 3, fertilizer package of 14-20-20-10 Kg/ha of NPKS with one N top dressing, seed rate of 90 Kg/ha and retention of 30 cm stubble height of T. aman rice. Results indicated that, the mean plant population was 33.66 per m^2, mean number of pod per plant was 35.33, seed per pod 5.67 and the mean green pod yield was found 7.5 t/ha.

Pest management

Effect of botanicals and synthetic chemicals on pea aphid, *Acyrthosiphonpisum*harris in fieldpea

A field trial was conducted at Pulses Research Centre (PRC), Ishurdi, Pabna during rabi season in 2019-20 to find out the effect of botanicals and synthetic chemicals on pea aphid, *Acyrthosiphonpisum* Harris in fieldpea. BARI Motor-3 was selected for this experiment. Aphid infestation was lower in imidachloprid (Imitaf 20 SL) treated plot (33.80%) which was statistically similar to dimethoate (Tafgor 40 EC), (35.00%) and neem oil (39.20%). The percent twig infestation by aphid was higher in control plot (77.50%) followed by spraying fresh water (75.00%). Aphid population were lower in dimethoate (Tafgor 40 EC) treated plot (6.14) which was statistically similar to all other treatment except control. Number of aphid per infested twig was higher in control plot (9.36). However, highest seed yield (2198 kg/ha) was obtained from treatment dimethoate (Tafgor 40 EC) which was statistically similar to imidachloprid (Imitaf 20 SL) (2163 kg/ha), neem oil (2128 kg/ha) and soap (detergent Wheel) water treatment (1947 kg/ha), respectively. The yield reduction in case of control plot (1673 kg/ha) as well as spraying tobacco powder solution (1692 kg/ha) and fresh water (1811 kg/ha) probably due to heavy infestation of aphid along with some other factors.

Grasspea

Varietal Improvement

Hybridization and advancement of generations

Hybridization on grasspea was conducted during rabi 2019-20 at PRC, Ishurdi, Pabna to create the genetic variability among the existing germplasm of grasspea. Six parents *viz.* Sirajgonj local, BARI Khesari-5, Narail Local, BKX 0003-1, BGP 13010 and Patuakhali local were used following half diallel fashion. A total of 303 successful crossed derived seeds were collected and harvested separately from fifteen cross combinations. Fifteen cross combinations of grasspea were grown along with their parents during the rabi season 2019-20 at PRC, Ishurdi, Pabna where a total of 25 individual F_1s plants have been confirmed and harvested separately. Six F_2 segregates were grown along with one check BARI khesari-3 and BARI khesari-5 to advance the generation during rabi, 2019-20 from which 70 single plants from six F_2s were selected and harvested separately.

Evaluation of grasspea exotic germplasm

The experiment was conducted for evaluation and seed multiplication of grasspea exotic germplasm during 2019-20 at PRC, Ishurdi, Pabna. A total of 42 genotypes along with one check BARI khesari-5 were evaluated. Variability was found in all the parameters of data. Finally, 19 genotypes were selected for further evaluation in replicated trial in the next season.

Evaluation of grasspea genotypes

The experiment was conducted at RARS, Rahmatpur, Barishal during Rabi season of 2019-20 to evaluate the local and exotic germplasm of grasspea genotypes/lines. Eight selected grasspea local and exotic lines *viz.* IGYT-125, IGYT-120, IGYT-124, IGYT-122, IGYT-110, IGYT-115, IGYT-123, IGYT-216 and one check variety BARI Kheshari-3 were evaluated in the trial. Results showed that all the characters under this study were not significantly different among the genotypes except number of pod/plant and seed yield. The highest seed yield was produced by the entry IGYT-216 (1790.4 kg/ha) and IGYT-125 (1783 Kg/ha) which is statistically identical to check variety BARI Kheshari-3 (1534.8 Kg/ha), IGYT-122 (1460.9 Kg/ha) and IGYT-123 (1446.7 Kg/ha). The lowest seed yield (556 kg/ha) was obtained in IGYT-115.

Regional yield trial of grasspea

The experiment was carried out to evaluate the performance of three grasspea genotypes along with check BARI Khesari-5 for yield and yield related traits in three locations *viz.* Pulses Research Centre, Ishurdi, Pabna; PRSS, Gazipur and ARS, Satkhira during Rabi 2019-20. Different genotypes of grasspea showed significant or non significant variations among all the parameters across all the environments. Considering mean data for both days to flower and maturity, BGP 13009 was found earlier. The genotype BGP 13010 gave the highest mean seed yield (1549 kg/ha) followed by BGP 13009 (1545 kg/ha) and the lowest (1401 kg/ha) yielded by BARI Khesari-5 across the locations. Compared to three locations, almost all the genotypes produced higher yield at Ishurdi. Considering yield, desired yield contributing characters and stability parameters, two genotypes BGP 13010 and BGP 13009 were selected for PVS trial in the next rabi season.

Evaluation of grasspea germplasm

An experiment was conducted at Pulses Research Centre, Ishurdi, Pabna and RPRS, Madaripur during Rabi 2019-20 to find out suitable and high yielding genotypes/variety of grasspea. Eight genotypes and two check variety *viz.* BARI Kheshari-3 and BARI Kheshari-5 were evaluated in this trial. Results revealed that all the yield contributing characters under study were significantly different among the genotypes. The maximum mean number of pods/plant obtained from BKX 0002-4 followed by Patuakhali local and the lowest in BARI Khesari-3. Mean 100 seeds weight ranged from 4.48-6.40 g. Maximum mean 100 seed weight obtained from BARI Khesari-3 followed by Patuakhali local and minimum in BGP 13009 followed by Narail local. The yield of the tested genotypes varied from 1085-1628 kg/ha. Comparatively the tested entries performed better yield at Ishurdi than Madaripur. Considering yield and other desirable characters, 4 genotypes *viz.* Narail local, Patuakhali local, BKX 0002-4 and BGP 13010 were selected for next year breeding trail.

Effect of shoot picking on growth and yield of grass pea

The field experiment was carried out at Pulses Research Centre and Regional Agricultural Research Station, Ishurdi during *rabi* season 2019-20 to find out the effect of shoot picking for vegetable on growth, yield and economic return of grass pea. The treatments used for the experiment were T_1 = One time Vegetable harvest at 40 DAE (days after emergence), T_2=Two times vegetable harvest at 40 & 50 DAE, T_3 = Three times vegetable harvest at 40, 50 &60 DAE, T_4 = Four times vegetable harvest at 40, 50, 60 & 70 DAE, T_5 = Two times vegetable harvest at 60 & 70 DAE and T_6 = Control. The result shows that one time shoot picking for vegetable gave higher seed yield but four times of shoot picking gave high amount of vegetable. However, the maximum gross return, gross margin and BCR were obtained from two time's vegetable harvest at 60 & 70 DAE.

Detoxification of odap in *lathyrus sativus* by various processing techniques

The present study aims to evaluate the detoxification of ODAP in grass pea seed samples collected from different locations of Bangladesh - Gazipur, Ishurdi and Jessore by various processing techniques of different soaking type roasting, boiling treatment, autoclaving with varying processing time of 30, 45, 60 minutes. The ODAP were estimated by the O-phthadehyde (OPT) method of Rao, 1978, resulting in a colored product on the reaction with DAP. The processing time was a vital factor, where we found that as the processing time is increased, the content of ODAP after processing is decreased manifold. It is also noticed that boiling after overnight soaking was the best method as 73% of ODAP was found to be eliminated. 20-73% detoxification of the toxin-ODAP can be seen by above processing methods. This investigation constitutes an effort to prevent neurolathyrism simultaneously by the detoxification of ODAP, employing various effective food processing techniques on the grass pea seeds deemed safe for human consumption.

Variation and correlation of morpho-agronomic traits and biochemical contents (ODAP) in grass pea (*lathyrus sativus* l.) Landraces

Ten landraces including four released variety of grass pea (*Lathyrus sativus* L.) were characterized by morpho-agronomic traits and neurotoxic ODAP (ß -*N*-oxalyl-L- a, ß –diamino-propionic acid) contents in seed. High variation was observed among landraces regarding all the studied traits. ODAP content was determined by OTP method by Rao, 1975 and extreme levels of ODAP were 1.33 and 5.39 mg g-1 in among the landraces. Also the strongest positive correlations were between no. of branches/plant, pod length, no of pods/plant and hundred seeds weight and between seed yield. Seed yield significantly ($p< 0.01$) and positively correlated with most of the investigated traits. Correlations between ODAP content and other traits were negative or no significant. In general, many of the landraces were superior with their seed yield and ODAP content.

Performance of mixed cropping of grass pea and mustard under relay cropping systems

The field experiment was carried out at Pulses Research Centre, Ishurdi, Pabna during 2019-20 to verify the performance of grass pea as mixed crop with mustard under relay cropping with T. *aman* rice. The treatment combinations used for the experiment were T_1: Sole grass pea (100% grass pea @ seed rate 60 Kg ha^{-1}), T_2: sole mustard (100% Mustard @ seed rate 7 Kg ha^{-1}), T_3:100% grass pea + 5 % mustard, T_4: 100% grass pea +10 % mustard, T_5: 80% grass pea + 15 % mustard, T_6: 80% grass pea + 20 % mustard. The result shows that sole mustard (T_2) gave the highest seed yield of mustard and 100% grass pea + 5 % mustard (T_3) contributed the minimum seed yield of mustard. On the other hand, yield and yield attributes of grass pea were not influenced significantly due to mixed cropping with mustard. Considering the yield and economic analysis, it can be concluded that 80% grass pea + 20 % mustard is more profitable than other treatment combinations.

Performance of different legumes as forage in southern region of Bangladesh

A field study was carried out at the farmer's field of Babuganj, Barishal to evaluate some pulses variety/genotyps to be used as forage in rabi season of 2019-20. The experiment was carried out with three different pulses variety/germplasms e.g. i) BARI Kheshari-3 ii) Serajgonj local and iii) BARI Motor-3 under randomized complete block design with three replications. Results revealed that, the highest green forage yield can be obtained from field pea variety BARI Motor-3 (51.5 t/ha) with BCR (6.67). Among grasspea variety/germplasm the highest green forage yield can be observed from

BARI Kheshari-3 (31.7t/ha) with BCR (5.34). The lowest yield and BCR was given by Serajgonj local (25.3t/ha and 4.06, respectively).

Fertilizer management for grasspea relay cropping system with T.aman rice in high ganges floodplain soil

A field experiment was conducted at the research field of Pulses Research Centre, Regional Agriculture Research Station, Ishurdi, Pabna during 2018-19 and 2019-20 to find out the suitable fertilizer dose for grasspea relay cropping system with T.aman rice in High Ganges Floodplain soil. The trial consisted of six nutrient treatments such as T_1 = Native (control), T_2 = Farmers practice, T_3 = FRG 2018, T_4 = FRG 2018+$Zn_{2.0}$, T_5 = FRG 2018+$B_{1.0}$, T_6 = FRG 2018+$Zn_{2.0}$+$B_{1.}$The experiment was designed randomized complete block with three replications. Result showed that application of different nutrient management proved effective in significantly enhancing the yield attributes and seed yield of grasspea. During 2018-19 and 2019-20 the maximum number pods per plant and number of seeds per pod were recorded from the treatment T_6 (FRG 2018+$Zn_{2.0}$+B_1) and T_5 (FRG 2018+$B_{1.}$) which was significantly different with the others treatments, but statistically identical to T_4 (FRG 2012+$Zn_{2.0}$) while it was lowest in control plot due to variation for nutrient supply. Maximum seed yield of grasspea was found treatment T_6 (FRG 2018+$Zn_{2.0}$+B_1) followed by treatment T_5 (FRG 2018+$B_{1.0}$) in both the year. Average of two years, regarding the cost and return analysis, the highest net return TK. 66700/ha was obtained from the treatment T_6. The highest benefit cost ratio 2.34 and 2.28 were recorded from the treatment T_6 and T_5. Therefore, it may be concluded that treatment T_6 (20-20-18-10-2-1 kg N-P-K-S-Zn-B/ha) and T_5 (20-20-18-10-1 kg N-P-K-S-B/ha) may be considered as economically sound and optimum fertilizer dose for yield maximization of grasspea production as relay with T.aman rice in High Ganges River Floodplain soil (AEZ # 11).

Comparative economic study of grasspea production with project and without project in some selected areas of Bangladesh

The study was carried out in three districts namely Chapai nawabgonj, Rajshahi and Madaripur to know the profitability of grasspea and its constraints to IFAD supported project and without project during 2019-2020. The study results revealed that the average per hectare variable cost, total cost, gross return and gross margin were found to be Tk. 17826, Tk. 46298, Tk. 46395 and Tk. 28569, respectively for IFAD supported project farmers while the average per hectare variable cost, total cost, gross return and gross margin were Tk. 15696, Tk. 44202, Tk. 36385 and Tk. 20689, respectively for without project. Benefit cost ration (BCR) on variable cost basis for IFAD supported project farmers was 2.61 and without project it was only 2.33. Almost all the farmers responded that more no. of training is important to know about new variety, improved production technology etc.

Lentil

Varietal Improvement

Hybridization and advancement of fillial generations in lentil

Hybridization and advancement of F_1 to F_5 generations were conducted during *Rabi* 2019-20 at PRC, Ishurdi, Pabna. Six parents were used in crosses and a total of 239 successful cross seeds were harvested from 15 cross combinations. Eleven, thirteen, five and ten populations and thirty five families were selected from F_1, F_2 F_3, F_4 and $F_{5,}$ respectively to advance the generation.

Observation trial of lentil

Twenty nine lines selected from last season's F_5 families were grown with check variety BARI Masur-8 during rabi season of 2019-20 at Pulses research center, Ishwardi, Pabna following RCB design with two replications. Evaluating the performance of yield, yield contributing traits and disease reaction, eleven genotypes out of 29- BLX-14008-1, BLX-14004-5, BLX-14001-1, BLX-14001-4, BLX-14001-12, BLX-14002-4, BLX-14002-6, BLX-14003-10, BLX-14004-3, BLX-14005-5 and BLX-14010-4-2 were selected for next year PYT.

Preliminary yield trial of lentil

The experiment was carried out to assess the performance of yield and yield contributing traits of eight lentil promising genotypes at three different locations *viz.*Ishwardi, Gazipur and Jashore during Rabi, 2019-20. Significant variations were observed among the genotypes in respects to yield and yield contributing traits. However, none of the entries was out yielded over check variety BARI Masur-8 but the yield of BLX13002-6, BLX13005-20 and BLX13005-26 was higher than BARI Masur-8. Considering different desirable traits and stability parameters three tested entries-BLX13005-26, BLX13005-20 and BLX13002-6 were selected for next year evaluation.

Regional yield trial of lentil

The experiment was conducted to evaluate the performance of yield and yield contributing traits as well as the stability of seven genotypes in four different locations *viz.*Ishurdi, Jamalpur, Gazipur and Jashore during Rabi, 2019-20. Significant variations were observed in respects to yield and yield contributing traits. The genotype BLX-11004-8 exhibited the highest seed yield followed by BLX- 11014-10 and BLX- 11014-8.Considering different desirable traits and stability parameters, BLX12005-4, BLX-11014-11, BLX-11004-8 and BLX-11014-8 were selected for next year evaluation at PVS trial.

Participatory variety selection of lentil

The experiment was carried out to assess the performance of yield and yield contributing traits of four genotypes of lentil at farmers' field of three locations *viz.* Pabna, Jashore and Madaripur during *Rabi*, 2019-20. There were no significant variations among the tested genotypes for all the studied traits across the locations. In regards to seed yield, none of the entries were out yielded over the check BARI Masur-7 and BARI Masur-8. The test entries will be preserved just as germplasm for future breeding purposes.

Evaluation of advanced lines of lentil under relay cropping

Six promising entries of lentil along with BARI Masur-8 as check were evaluated as relay cropping at Pulses Research Centre, Ishwardi, Pabna during Rabi season 2019-20 in a RCB design with 3 replications to select suitable genotypes for relay cropping with T. aman rice. Significant genotypic differences were observed in case of all yield contributing characters except seed weight. The entries BLX – 05002-6 exhibited the highest yield followed by BLX – 13004-3, BLX – 05002-3 and BLX – 04005-9. Considering yield, yield contributing traits and disease incidence, four entries *viz.* BLX – 05002-6, BLX – 05002-3, BLX – 04005-9 and BLX – 13004-3 were selected for further evaluation next year to confirm the results.

Crop nutrition

Effects of foliar application of flora on growth and yield parameters of lentil

A field experiment was conducted at Pulses Research Centre (PRC) and Pulses Research Station (RARS) during the rabi season of 2019-20 to investigate the effects of foliar application of flora on yield and yield components of lentil. There were four concentration levels of FLORA @ 1.0 ml/water, 2.0 ml/water, 2.5 ml/water, 3.0 ml/water were applied to the plant which were compared to control (untreated control water spray and absolute control). Foliar applications of FLORA were carried out at three times at different growth stages of lentil (24 DAS, 49 DAS and 74 Days).The experiment was arranged in a randomized complete block design and replicated three times. Parameters measured were grain and straw yield, plant population/ m², plant height, number of pods/plant, number of seeds/pod and 1000-grain weight. There were no significant differences between the foliar applications of flora for any of the measured parameters of lentil. Although the yield of lentil was not significantly affected due to foliar application of flora, the experiment will be repeated in the next year for conclusion.

Phenology, growth and yield of lentil as influenced by sowing time and seed rate

A field experiment was conducted at Pulses Research Centre and Regional Agricultural Research Station, Ishurdi during rabi season 2019-20 to study the effect of sowing time and seed rate on phenology, growth and yield of BARI Masur-8. The experiment was laid with four sowing dates (01 November, 15 November, 1 December, 15 December) in main plots and four seed rates (30 kg ha^{-1}, 35 kg ha^{-1}, 40 kg $ha^{-1}$and 45 kg ha^{-1}) in sub-plots replicated thrice in a split-plot design. Lentil sown on 01 November took 118 days from sowing to maturity, which was decreased by 22 days on 01 December and 30 days on 15 December sowings. Lentil sown on 15 November with seed rate of 40 kg ha-1 gave the highest seed yield (2397 kg ha-1) and the lowest yield (1308 kg ha-1) was obtained from 30 kg ha-1 seed rate with sown on 01 November.

Efficacy of herbicides for controlling weeds in lentil field

A field experiment was conducted at Pulses Research Centre, Ishurdi, Pabna during 2019-20 to find out the efficacy of herbicides on weed control and crop response in lentil. Eleven treatments viz. T_1= Whip super 9EC (Pre-emergence), T_2= Weednil 5 EC (Pre-emergence), T_3= Panida 33 EC (Pre-emergence), T_4= Whip super 9EC (Pre-emergence and post-emergence), T_5= Weednil 5 EC (Pre-emergence and post-emergence), T6= Panida 33 EC (Pre-emergence) and Whip super 9EC (post-emergence), T_7= Panida 33 EC (Pre-emergence) and Weednil 5 EC (Post-emergence), T_8= Whip super 9EC (Post-emergence), T_9= Weednil 5 EC (Post-emergence), T_{10}= Hand weeding and T_{11}= Control (No weeding) were included in this experiment. Herbicides were applied at moist condition of soil after irrigation for proper seed germination that means pre-emergence condition and post emergence at 20 days after lentil emergence. The experiment was laid out in a randomized complete block design with three replications. Panida 33 EC (Pre-emergence) with Whip super 9 EC (post-emergence) and Panida 33 EC (Pre-emergence) with Weednil 5 EC (Post-emergence) were suitable treatment for weed control in lentil. These gave higher branches plant^{-1}, pods plant^{-1} and consequently gave higher yield. The highest gross return, gross margin and BCR was obtained from T_7.

On-farm relay sowing package of lentil in Barishal district

An on farm trial was conducted on farm relay sowing package of lentil at Rakudia, Babuganj upazilla of Barishal, Manikkathi, Babuganj, Barishal and Charamaddi, Barishal sadar during Rabi season of 2019-20. BARI Masur-8 was used as variety and it was relay sown with T.aman rice. The improved management practices included improved variety. BARI Masur-8, fertilizer package of 14-20-20-10 kg/ha of NPKS with Nitrogen top dressing, seed rate of 60 Kg/ha and 25 cm stubble height retention of T.aman rice. Results indicated that, the mean plant population was 172 $^{-}$m^2, mean number of pod per plant was 45, seed per pod 2 and the mean seed yield was found 1457 Kg/ha.

Pest management

Effectiveness of fungicides and their application timing for the management of stemphylium blight disease of lentil

The experiment was conducted at Pulses Research Centre, Ishurdi, Pabna during 2019-20 to find effective dose of fungicides as well as application timing for the management of stemphylium blight disease of lentil. Under factorial arrangement, two fungicides with dose, a control and three application timings were compared for stemphylium blight disease control, profitability of fungicide application and grain yield. The highest yield (1807 kg/ha) was obtained when Folicur was sprayed three times @ 1ml/L which showed no significant difference with the combination of other fungicide dose and spray schedule. Economic analysis demonstrated that Folicur @ 1ml/L and one spray incurred the highest Marginal Benefit Cost Ratio (MBCR, 14.2). Results suggest that when disease onset occurs at or prior to flowering a double application of with 1 ml or 1g/L dose of folicur and nativo fungicide, respectively reduces disease, protects yields and increase income.

Effect of different level of phosphorus and their integration with manures on different crops in the lentil-mungbean-T.aman rice cropping pattern

An experiment was conducted at the research field of Pulses Research Centre, Ishurdi, Pabna during 2018-19 and 2019-2020 to determine the optimum rates of phosphorus for lentil-mungbean-T.aman rice cropping pattern and to reduce the rate of P fertilizer application by inclusion of cowdung and poultry manure. There were 8 treatments viz. T_1=P_0, T_2= P16 kg/ha, T_3=P 32 kg/ha, T_4=P 48 kg/ha, T_5=P 16 kg/ha+Cowdung-5 t/ha, T_6=P 16 kg/ha + Poultry manure 3 t/ha, T_7 = P 32 kg/ha + Cowdung-5 t/ha, T_8= P 32 kg/ha +Poultry manure 3 t/ha. The experiment was designed randomized complete block with three replications. Result showed that application of different level of P and manures proved effective in significantly enhancing the nodulation, yield attributes and seed yield of lentil during both the year. The tallest plant, number of branch and maximum number of pods per plant were recorded from the P fertilizer with cowdung and poultry manure treatments. Seed yield of lentil was significantly influenced by organic and inorganic sources of phosphorus during 2018-19 and 2019-2020. Maximum seed yield was found in the treatment T_5 and T_6 (P fertilizer with manure).This was significantly higher than the other treatments. The maximum numbers of nodules were recorded from the treatment T_8 (P 32 kg/ha with 3 t/ha poultry manure) in all the nodules collection dates which was significantly higher over the other treatment in both years. The lowest nodule values were obtained from the P control treatment. Average of two years, maximum net return TK. 180000/ha was obtained from the treatment T_6 (P 16 kg/ha with 3 t/ha poultry manure). The highest benefit cost ratio 4.05 and 3.4.0 were recorded from the treatment T_5 and T_6 (P fertilizer with manure). Therefore, it may be concluded that 16 kg/ha phosphorus fertilizer along with cowdung-5 t/ha or poultry manure 3 t/ha with a blanket dose of $N_{20}K_{20}S_{10}$ Zn_2 B_1 kg/ha may be considered as economically sound and optimum fertilizer dose for yield maximization of lentil production in High Ganges River Floodplain soil under lentil-mungbean-T.aman rice cropping pattern.

Integrated nutrient management for lentil+mustard mixed cropping system

A field experiment was conducted at the research field of Pulses Research Centre and Regional Agriculture Research Station, Ishurdi, Pabna during 2018-19 and 2019-2020 to find out the suitable fertilizer dose for lentil+mustard mixed cropping system in High Ganges Floodplain soil. The trial consisted of eight nutrient treatments such as T_1= MYG based on soil test, T_2= HYG based on soil test, T_3=IPNS with 5 t/ha for HYG, T_4=T_1 + 25% of T_1, T_5= T_2 + 25% of T_2, T_6=According to FRG 2012, T_7 = Farmers practice, T_8= Native fertility (Control).The experiment was designed randomized complete block with three replications. For mixed cropping system, 70% lentil + 30 % mustard seeds were sown. Result showed that application of different nutrient management proved effective in significantly enhancing the yield attributes and seed yield of lentil and mustard mixed cropping system in both the years. During 2018-19 and 2019-2020, the maximum number of pods per plant and seed yield of lentil and mustard were recorded from the treatment T_5 (T_2 + 25% of T_2) and T_3 (IPNS with 5 t/ha for HYG) which was significantly different with the others treatments but it was the lowest in control treatment due to variation for nutrient supply. Maximum lentil equivalent yield was found in T_5 (HYG based on soil test + 25% of T_2) followed by treatment T_3 (IPNS with 5 t/ha for HYG) in the year of 2018-19 and 2019-20. Average of two years, regarding the cost and return analysis, the highest net return TK. 172000/ha was obtained from the treatment T_5. The highest benefit cost ratio 3.89 and 3.70 were recorded from the treatment T_5 and $T_{3,}$ respectively. Therefore, it may be concluded that treatment T_5 (35-50-62-40-3.75-1.25 kg N-P-K-S-Zn-B/ha) and T_3 (30-28-42-30-3-1kg N-P-K-S-Zn-B/ha + 5 ton cowdung/ha) may be considered as economically profitable and optimum fertilizer dose for yield maximization of lentil+mustard mixed crop production in High Ganges River Floodplain soil (AEZ # 11).

Mungbean

Varietal Improvement

Hybridization and advancement of fillial generations in mungbean

Hybridization and advancement of F_1 to F_5 generations were conducted during Kharif- I, 2020 at PRC, Ishurdi, Pabna. Seven parents were used in crosses and a total of 345 successful cross seeds were harvested from nine cross combinations. Twelve, nine and twelve populations and eleven families were selected from F_1, F_3, F_4 and F_5 respectively to advance the generation.

Candidate variety demonstration trial of mungbean

The experiment was conducted to evaluate the performance of promising advance lines in large plots to select a high yielding and disease resistant mungbean variety. Three lines- BMXK1-10011-3, BMXK1-112002-21 and BMX-010025 along with BARI Mung-8 as a check variety were sown at Pulses Research Centre, Ishurdi, Pabna during Kharif 1, 2020. Results showed that the line BMX-010025 produced the highest seed yield (641 kg ha^{-1}) with the first picking of pods while the second and third flash of pods were damaged by continuous rain.The trial will be repeated in the next year for further confirmation.

Participatory varietal selection of mungbean

Four entries with two check varieties BARI Mung-6 and BARI Mung-8 were evaluated at PRC, Ishurdi; and RPRS, Madaripur in a RCB design with 3 replications to select high yielding and disease resistant line for releasing as variety with the direct involvement of farmers. None of the test entries was out yielded over check varieties. The entries will be preserves as germplasm for future breeding purposes.

Application of growth regulator for synchronizing ripening of mungbean

A field experiment was conducted at the research field of Pulses Research Centre, Ishurdi and PRSS, BARI, Gazipur during 2019-20 to find out the suitable growth regulator to synchronize ripening of mugbean. There were six treatments viz T_1= Glycel (Glyphosate, 3.70 L/ha), T_2=Gramoxone (Paraquat, 2.25 L/ha), T_3=Great boss (Paraquat 20% and Glyphosate 41%), T_4= Bonmara (2, 4-D Amine, 2.80 L/ha), T_5= Ripen-15 (Ethephon, 1 L/ha) and T_6=Control. Treatments did not show significant effect on the yield contributing characters of mugbean. The highest gross return was obtained from Gramoxon (Tk. 42660) at Ishurdi and Ripen-15 (Tk. 47820) at Gazipur, but the highest MBCR (4.61and 5.02 at Ishurdi and Gazipur, respectively) were got from Gramoxon. It required less labour at harvesting avoiding labour cost for picking up of ripen pods, and dried plants with pods were harvested at a time easily by hand within four days. It was found that permanent and glyph site is more effective for killing the plant But this experiment should be continued for the net year for final decision.

Weed control in mungbean cultivation in late rabi season

A field study was carried out at the farmer's field of Rahmatpur, Babuganj, Barishal to evaluate some weed control options in mungbean cultivation in late rabi season of 2020. The experiment was carried out with five different weed control options e.g. i) Control (W_1) ii) One hand weeding at 20 DAE (W_2), iii) BARI weeder at 20 DAE (W_3), iv) W_2 + BARI weeder at 20 DAE (W_4) v) Weednil @1.5ml/L water at 20 DAE (W_5) under randomized complete block design with three replications. BARI Mung-6 was used as the variety. Results revealed that, one hand weeding at 20 DAE + application of BARI Weeder; spraying of weednil @ 1.5 ml/L significantly increases seed yield of mungbean (1539.2 and 1504.1 kg/ha, respectively). The highest BCR can be found from spraying of weednil @ 1.5ml/L treatment (3.01).

Pest management

Foliar application of commercially available micro and macro-nutrients for the management of flower thrips and pod borers of mungbean

The effect of foliar application of micro and macro-nutrients on different growth stage of mungbean against flower thrips and pod borers of mungbean was studied at Pulses Research Centre, Ishurdi, Pabna, Bangladesh during kharif-I, 2020. Flower and pod borer infestation was reduced significantly by the application of micro and macro-nutrients in mungbean. Flower infestation reduction over control ranged from 5.45 to 14.55% and pod infestation reduction ranged from 12.85 to 40.02%. The highest percentage of flower infestation reduction (14.55%) was found in Thiovit sprayed plots followed by Nutra-phos and the highest percentage of pod borer infestation reduction (40.02%) was found in Muriate of Potash sprayed plots followed by Thiovit. The yield increase over control ranged from 2.58 to 13.22%. The highest yield obtained from McChili+Solubor sprayed plots but the highest benefit comes from Thiovit. This might be due to lower cost of Thiovit uplift the profit margin and showed the higher MBCR than that of McChili+Solubor sprayed treatment. So, it is found that foliar application of Thiovit or McChili+ Solubor would be profitable option for managing flower thrips and pod borers of mungbean with higher yield compared to untreated ones.

Evaluation of some integrated management packages against flower thrips and pod borers of mungbean

Effectiveness of integrated management approaches using blue sticky trap, bio and synthetic insecticides were evaluated against flower thrips and pod borers of mungbean at Pulses Research Centre, Ishurdi, Pabna, Bangladesh during kharif-I 2020. All of the management packages significantly reduced flower infestation, thrips population and pod borer infestation in mungbean. The highest percentage of reduction of flower infestation and thrips population was observed in the IPM package 3: (Installing blue sticky trap + two spraying of chlorfenapyr (Intrepid 10 EC) @ 1 ml/l at 100% flowering and 100% podding stage + third spraying with Emamectin Benzoate (Proclaim 5 SG) @ 1 g/l at seed developing stage) followed by farmers practice. But the highest pod borer infestation reduction was found in IPM package 2 followed by IPM package 3, IPM package 1 and farmers practice.The highest yield and accordingly additional return come from IPM package 2: (Installing blue sticky trap + two spraying of Bio-Chamak (*Celastrusangulatus* 1% EW) @ 2.5 ml/l at 100% flowering and 100% podding stage + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l at seed developing stage) followed by farmers practice and IPM package 1. But the highest benefit (MBCR 3.39) comes from recommended practice (Farmers practice). This might be due to higher cost of IPM components brought down the profit margin and showed the lower MBCR than that of recommended practice (farmer's practice). Although IPM packages under this study are not financially profitable as recommended practice but considering environment friendliness, the IPM package 2: (Installing blue sticky trap + two spraying of Bio-Chamak (*Celastrusangulatus* 1% EW) @ 2.5 ml/l at 100% flowering and 100% podding stage + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l at seed developing stage) would be the best package for controlling flower thrips and pod borers of mungbean with higher yield in the insects prone cropping areas without harming the ecosystem.

Response of promising mungbean varieties / entries against flower thrips and pod borers

Response of promising varieties/entries of mungbean against flower thrips and pod borers were studied at Pulses Research Centre, Ishurdi, Pabna, Bangladesh during kharif-I, 2020. Flower infestation, thrips population and pod borer infestation varied significantly among the varieties/entries. The lowest flower infestation, thrips population and pod borer infestation was found in BARI Mung-8. So, BARI Mung -8 showed more resistance among the varieties/entries under this study. The highest yield (1086 kg/ha) was obtained from BINA Mung-8 followed by BMXK1 08011-2 (1027 kg/ha). The yield of BMXK1 08011-2 was the highest in previous year followed by BINA Mung-8. So, the entry BMXK1 08011-2 found best which would a new promising variety in the near future after multi-location trials following necessary procedures.

Screening/Performance of cultivars/ varieties

Pigeon pea

Screening of pigeon pea genotypes for higher yield

The study was conducted at Pulses Research Centre, Ishurdi, Pabna during rabi season of 2019-2020 to find out the suitable genotypes of pigeon pea for higher yield. The experiment involved thirty one pigeon pea germplasm. The experiment was laid out in Randomized Complete Block design with three dispersed replications. Results revealed that the minimum duration of flower (187 days) was observed in Naogaon Local where maximum duration (279.00 days) was found in BD-3114 genotype. Yield per plant varied from 15 g to 587 g, where Naogaon Local and BD-3121 gave higher yield (587 g and 328 g per plant, respectively), 20 accessions were moderate yield (101-295 g per plant) and the rest 9 accessions were low yield (15−100 g per plant). The lowest seed yield (15 g per plant) from BD-3131 pigeon pea accession.

Regional Agricultural Research Centre, Ishurdi, Pabna

Horticulture Division

Regional yield trial of pointed gourd hybrids

An experiment was carried out at Regional Agricultural Research Station, Ishurdi, Pabna during Rabi season of 2018-19 to evaluate the performance of five promising hybrid pointed gourd lines regarding yield and desirable characters. Five lines of hybrid pointed gourd viz. PG008xM_1, PG008×M_2, PG009×M_2, PG014xM_1, PG018×M_2 and BARI Hybrid Potol-1 were included in the experiment. The experiment was laid out in RCB design with three replications. The unit plot size was 4.5 m × 1.0 m maintaining 1.5 m × 1.0 m spacing. Vines were planted on 23 October 2018. The earliest anthesis of female flower (106 days) and fruit harvesting (127 days) was occurred in BARI Hybrid Patol-l. The longest fruit (12.31 cm) and widest fruit (3.83 cm) was recorded from BARI Hybrid Patol-l. The highest number of fruits per plant (154) was obtained from PG009 × M_2 and the lowest number of fruit per plant (103) was obtained from PG018 × M_2. Average fruit weight was also found highest (53 g) in BARI Hybrid Potol-1. The highest yield (52.59 t/ha) was obtained from PG009 × M_2 and it was might be due to the highest number of fruit per plant and the lowest yield (35.14 t/ha) was obtained from PG008xM_1. The hybrid line PG009 × M_2 also performed well considering five locations. Considering yield PG009xM_2 was promising. It might be released as a hybrid variety

Collection and evaluation of hyacinth bean germplasm

Performance of Twenty hyacinth bean lines collected from Ishurdi region were investigated at RARS, Ishurdi, Pabna during Rabi season of 2019-20 to find out suitable lines for the development of new variety. Twenty hyacinth bean genotypes were included in the study. The unit plot size was 3.0 x 1.0 m. Three plants were planted in each plot. Seeds were sown on 20 September 2019 and transplanted in the main plot on 10 October 2019. The earliest flowering (57 days) was observed in Dl Isd 015 and the delayed flowering (98 days) in Dl Isd 005. Number of fruits per plant ranged from 40 to 225 and was maximum (225) in DL Isd-006 whereas, minimum (40) was in Dl Isd-018. The highest average fruit weight (20 g) was recorded from DL Isd-009 and the lowest (7 g) was in DL Isd-001 and DL Isd 020. Fruit length and breadth ranged from 7.00-15.60 cm and 1.80-4.67 cm, respectively. However, the longest fruit (15.60 cm) was recorded from DL Isd-009 followed by DL Isd 012 and shortest fruit (7.00 cm) from DL Isd-019. On the other hand, the widest fruit (4.67 cm) was recorded from DL Isd-009 and narrowest fruit (1.80 cm) from DL Isd-019. Weight of fruits per plant and yield varied among the genotypes. The highest fruit weight (2.56 kg) as well as yield (25.80 t/ha) was obtained from DL Isd-010 and lowest yield (5.000 t/ha) was obtained from DL Isd-020. Considering yield DL Isd-003, DL Isd-004, DL Isd-009, DL Isd-010 and DL Isd-014 found promising. Selected superior germplasm will be more precisely evaluated.

Clonal selection of banana CV. Sabri

Seventeen sabri banana germplasm was collected from Ishurdi region and planted at Regional Agricultural Research Station Ishurdi, Pabna to evaluate and identify the suitable lines during 2019-2020. Twenty local Sabri germplasm were included in the study. The experiment was laid out in a randomized complete block design with three replications. Unit plot size was 4.0 x 4.0 in accommodating 4.0 plants. Maximum number of leaves was obtained from MS Isd-008 and MS ISd-009 (15) whereas MS Isd-015 produced the minimum leaves (11). The highest bunch weight (22.95 kg) was found in MS Isd-009 MS Isd-002 produced the highest number of fingers per hand (19) whereas, MS Isd-020 got the lowest (14). However, the highest fruit yield (57.38 t/ha) was obtained from MS Isd-009 followed by MS Isd-002 (56.13 t/ha) and the lowest yield (30.75 t/ha) in MS Isd-012. MS Isd-002 exhibited the highest edible portion (82.05%). TSS ranged 18.8-21.8. Based on the results it may be concluded that the accession MS Isd-002, MS Isd-003, MS Isd-005, MS Isd-019, MS Isd-016 and MS Isd-048 performed better in terms of yield and yield contributing characters. This is first second of evaluation. Selected superior germplasm will be more precisely evaluated.

Breeder seed production

Sl. No.	Crop	Variety	Quantity (kg)	Remarks
1	Spinach	BARI Puishak-2	6.50	Kharif, 2019
2	Kangkong	BARI Gimakolmi-1	3.00	
3	Stem amaranth	BARI Danta-1	2.50	
4	Tomato	BARI Tomato-14	0.20	Rabi, 2019-20
		BARI Tomato-19	0.25	
		BARI Tomato-20	0.10	
5	Eggplant	BARI Begun-1	4.00	
		BARI Begun-4	3.50	
		BARI Begun-6	3.50	
6	Red amaranth	BARI Lalshak-1	9.00	
7	Garden pea	BARI Motorshuti-1	120.00	
		BARI Motorshuti-3	40.00	
8	Spinach	BARI Palongshak-1	30.00	
9	Hyacinth bean	BARI Sheem-6	3.50	
10	Bush bean	BARI Jharsheem-1	1.00	
11	Capsicum	BARI Mistimorich-2	0.05	
12	Bottle gourd	BARI Lau-3	2.00	
13	Pointed gourd (Vine/seedling)	BARI Hybrid Patol-1	2000	
		BARI Patol-1	1000	
		BARI Patol-2	500	
		Male plant	100	

Sl. No.	Item	Amount
1	Seed	227.10 Kg
2	Seedling	5000 nos
3	Cuttings	3600 nos

Sapling/seedling production

Sl. no.	Variety	Quantity (No.)	Distribution/ sale
1	BARI Aam-3	400	100
2	BARI Aam-4	1500	1000
3	BARI Batabilebu-4	200	150
4	BARI Batabilebu- 6	500	400
5	BARI Peyara-2	250	100
6	BARI Malta-1	50	-
Total		**2900**	**1800**

Training/ Field day

Sl. No.	Topics	Batch	No. of participants
1	Farmers training on 'Improved production technology of summer vegetable'.	1	40
2	Farmers training on 'Improved production technology of winter vegetable'.	1	40
3	Farmers training on 'Improved production technology of fruit crops'.	1	40
4	Field day on BARI Longan-1	1	100

Integrated management of *orobanche* of mustard

The trial was conducted at Regional Agricultural Research Station Ishurdi, Pabna during Rabi season of 2019-20 to find out one / more effective management practices against *Orobanche* of mustard. Eight treatments viz. T_1= *Tricho* compost @ 1 t/ha as basal application, T_2=Glyphoshate @ 60 ml and 120 ml/ha at 30 days after sowing (DAS) and 55 DAS, T_3=Glyphoshate @ 60 ml/ha along with 1% solution of $(NH_4)_2SO_4$ at 40 DAS, T_4= Pendimethalin @ 2.0 l/ha pre-plant incorporation, T_5= Pendimethalin @ 2.0 l/ha + neem oil 1% pre-plant incorporation, T_6= 125% of recommended fertilizer (N & P) + Glyphoshate @

60ml and 120 ml/ha with 1% solution of $(NH_4)_2SO_4$ at 30 DAS and 55 DAS, T_7= Neem oil cake @400 kg/ha + soil drenching of Metalaxyl @0.2% at 30 DAS + Glyphoshate @ 100ml/ha at 45 DAS and T_8= Control were tested for their performance against the disease. All the treatments gave satisfactory reduction of orobanche and increased plant growth as well as yield of mustard.The number of orobanche/m^2 ranged from 1.11 – 49.22.The lowest was found in treatment T_6 and the highest was recorded in control plots. The highest number of *Orobanche* reduction over control (97.74%) was recorded in treatment T_6.The highest yield (1229 kg/ha) was recorded from treatment T_6 and the lowest yield (736 kg/ha) was found in control plots.

Integrated management of leaf curl virus disease of chili using nylon net, chemicals, bio-pesticides and barrier crop

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during rabi season 2019-20 to find out the effective management practices for controlling leaf curl virus disease of chili. Seven treatments viz.T_1=Growing of nursery under Nylon net cover (60-80) mesh, T_2=Barrier crop (maize) was grown in three rows all around the main field 15 days before the transplanting of chili, T_3=Spray Neem oil (Azadiractin) @ 5 ml/l, T_4=Spray Imitaf (Imidacloprid) @ 0.25 ml/l, T_5= T_1 + T_2+ T_3, T_6= T_1 + T_2+ T_4, T_7= Control were used in this experiment. The incidence of virus infected chili plants ranged from 21.94% – 90.28% while the highest was recorded in control plot and the lowest was found in treatment T_6 which is statistically identical to treatment T_5. The highest yield (4.17 t/ha) was recorded in treatment T_6 which statistically identical to treatment T_5 (3.91 t/ha) and the lowest (2.95 t/ha) was obtained in control plots.

Fungicidal management of alternaria leaf spot and flower blight disease of marigold

A field experiment was conducted at Regional agricultural Research Station Ishurdi, Pabna during Rabi season of 2019-2020 to find out effective fungicides against *Alternaria* leaf spot and flower blight of marigold. Local vareity of marigold was used in the study. Eight different fungicides viz. T_1= Tilt 250 EC @ 0.05%T_2= Autostin 50 WDG @ 0.2%,T_3= Rovral50 WP@ 0.2% T_4= Contaf 5EC @ 0.1%T_5= Companion @ 0.2%T_6= Score 250 EC @ 0.2% T_7= Indofil M 45 @ 0.2% T_8= Secure 600wg @0.2% and one unsprayed Control were used in this experiment. Among the treatments the lowest severity of leaf spot (6.67%) and flower blight (8.33%) were found in score 250 EC followed by indofilM45, secure 600wg and rovral 50 WP.The highest severity of leaf spot (31.00%) and flower blight (33.6%) were found in control plots. The highest no.of flower/ plant (35.07) was recorded from Score 250 EC @ 0.2% sprayed plot whereas, the lowest (21.6) was recorded from control plots.

Effect of irrigation in controlling common scab disease and yield of potato

An experiment was conducted at RARS Ishurdi during the Rabi season of 2019-2020 to investegate the yield and scab infection of susceptable potato variety Diamant under different quantity of irrigation/ irrigation levels and number of irrigation. There were two irrigation levels viz. 1. 50% of the ridge 2. 75% of the ridge. For each irrigation levels there were 5 treatments viz. 1. One irrigation at 25 DAP 2. One irrigation at 40 DAP 3. Two irrigation at 25 &40 DAP 4. Three irrigation at 25,40 & 50 DAP 5. Four irrigation at 25,40,50 & 65 DAP. The range of Scab infection was 51.79%-76.08% on the basis of yield but no significant differerance was observed among the treatments.In case of yield, the highest yield (32.81 ton/ ha) was obtained from 75% X Two irrigation followed by 75% X Four irrigation (32.23 t/ha). Incase of yield there was no significant difference among the treatments.

Rapeseed - mustard (*Brassica spp.*)

Variety Development

Development of BC_2S_6 generation in *Brassica rapa*

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-9 (S_4) and Improved Tori-7 (S_4) 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_1, BC_2S_2 BC_2S_3 and BC_2S_4 were developed during 2014-15, 2015-16, 2016-17 and 2017-18, respectively. BC_2S_5 seeds were sown on 5 December 2019 to develop BC_2S_6. Unit plot size was 4 rows 3 m long. Proper netting of each cross combinations was done to protect out crossing and to encourage intramating among the same population.

Results of six cross combinations of BC_2S_6 generation of *Brassica rapa d*ays to flowering and maturity of cross combinations were ranged from 28-32 days and 81-92 days, respectively. Seeds were stored to evaluate large plot evaluation trial as well as advance BC_2S_7 generation in the next year.

Growing of F_3 generation originated from 16 parents of *B. rapa*

Eight brown sarson parents and eight yellow sarson parents were utilized to produce single crosses from different varieties developed as well as advanced lines of rapeseed-mustard. Single crosses were made in 2013-14 following double-crosses in 2014-15. Complex crosses were done in 2015-16 and 2016-17 to accumulate desirable genes into a single parent. F_1 and F_2 generation were developed in 2017-18 and 18-19 respectively. The F_3 seeds along with the parents were sown on 1 December 2019. The selected progenies from F_3 seeds were allowed to grown space planted having a large plot to select desired plant types. Intercultural operations were done when necessary.

A total of 254 single plants were harvested of which 60 were yellow seeded and their performance are days to flowering and days to maturity ranged from 33-40 days and 87-97 days respectively. Plant height ranged from 91-148 cm. The number of pod per plant ranged from 35-305. No. of Seeds per pod ranged from 10-38. Seed yield per plant ranged from 2-33gm. The seeds of selected single plants with desirable characters were stored separately for next year sowing as the F_4 generation.

Evaluation of F_4 generation in *Brassica rapa*

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-17 and BARI Sarisha-6 were used as female parents and S_6 generation of BARI Sarisha-9 and Tori-7 were used as male parents to develop single crosses during rabi 2014-15. F_1s were grown during rabi 2015-16 and crossed with BARI Sarisha-6 and BARI Sarisha-17 to develop three-way crosses. F_1 –F_3 were developed through selfing during 2016-19. F_4 seeds of three-way crosses of eight cross combinations were sown on 5 December 2019 at Joydebpur. Unit plot size was 5 rows × 3 m long. Selfing was done through bud pollination to produce F_5 generation.

Results of F_4s of eight three-way cross combinations of *Brassica rapa* are No. of selfed plants from different cross combinations ranged from 20-40 and total 236 plants were selfed. One thousand four hundred and twenty two buds were selfed from 236 plants to develop F_5 generation. Eight hundred and fifty three siliquae were obtained from which three thousand four hundred and fourteen seeds were obtained. Selfed seeds were stored to advance F_5 generation in the next season.

Evaluation of segregating generations of *Brassica rapa*

F_6 generation

Families of F_6 generation of two cross combinations having both yellow and brown seed coat colour were evaluated during *rabi* 2019-20 at Joydebpur. Families were sown following family to row method along with BARI Sarisha-14 as check in 4-rows 3 m long plot with spacing 30 cm and 5 cm between rows and plants, respectively. Seeding was done on 28 November 2019. Single plant selection among families was done based on short duration (maturity duration up to 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

F_6 generation

Families of F_6 generation of five cross combinations having both yellow and brown seed coat colour were evaluated during rabi 2019-20 at Joydebpur. Families were sown following family to row method along with BARI Sarisha-14 as check in 4-rows 3m long plot with spacing 30cm and 5cm between rows and plants, respectively. Seeding was done on 28 November 2019. Single plant selection among families was done based on short duration (maturity duration up to 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

Results

F_6 generation

Three families having yellow seed coat colour of one cross combination and three families having brown seed coat colour of two cross combinations were evaluated. Considering earliness (maturity duration up to 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, all families were selected for further evaluation. Seeds of selected plants of individual family were bulked and stored for evaluation in F_6 generation in the next year.

F_6 generation

The results of F_6 generation are presented in Table 5. Twenty families having yellow seed coat colour of four cross combinations and three families having brown seed coat colour of one cross combination were evaluated. Considering earliness (maturity duration up to 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, all were selected for further evaluation. Seeds of selected plants were bulked and stored for evaluation in the next year.

Observation trial of *Brassica rapa* (Set-I)

Sixteen lines of *Brassica rapa* having yellow flower and yellow seed coat colour were selected last year from F_6 generation of different cross combinations. These lines along with check as BARI Sarisha-14 were evaluated with two replications under Observation Trial of *Brassica rapa* (Set-I) at Joydebpur during 2019-20. The lines were sown on 25 November 2019 in 3 rows of 3m long with spacing of 30 cm and 5 cm between rows and plants, respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MoP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of siliquae/plant, no. of seeds/siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha.

Variations were observed among the lines for no. of seed/siliqua and seed yield. Maturity duration ranged from 84-90 days. Three lines were matured within 85 days whereas check variety BARI Sarisha-14 took 86 days. Plant height ranged from 78-98 cm. Number of siliquae/plant ranged from 37-81. The highest number of siliquae/plant recorded in BC-2014-Y01. No. of seeds/siliqua ranged from 14-36. The highest number of seeds/siliqua recorded in BC-2014-Y02-1. Seed yield ranged from 778-2043 kg/ha. The highest seed yield recorded in BC-2014-B08 (2043 kg/ha).

Considering earliness, seed yield and other yield contributing characters, three lines BC-2014-B08, BS-14x-BS-15-1-1 and BC-2014-B14 were selected for the next trial.

Observation trial of *Brassica rapa* (Set-II)

Twelve lines of *Brassica rapa* having yellow flower and brown seed coat colour were selected last year from F_6 generation of different cross combinations. These lines along with one check as BARI Sarisha-9 were evaluated with two replications under Observation Trial of *Brassica rapa* (Set-II) at Joydebpur during 2019-20. The lines were sown on 25 November 2019 in 3 rows of 3 m long with spacing of 30 cm and 5 cm between rows and plants, respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MoP, Gypsum, zinc Sulphate and Boric acid, respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of siliquae/plant, no. of seeds/siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha.

Variation was observed in number of seed/siliqua. Maturity duration ranged from 88-90 days. Plant height ranged from 89-103 cm. The highest plant height was recorded in BS-14 x -SAU-1-4. Number of siliquae/plant ranged from 71-116. The highest number of siliquae/plant was recorded in BS-6 x-BS-1-6. Number of seeds/siliqua ranged from 15-33. Seed yield ranged from 1480-2346 kg/ha. The highest seed yield recorded in BS-6 x -SAU-1-3 (1876 kg/ha). Considering earliness, seed yield and other yield contributing characters, four lines BS-6 x -SAU-1-3, BS-14 x SAU-1-4, BS-6 x -SAU-1-1 and BS-15 x- SAU-1-1 were selected for the next trial.

Preliminary yield trial of *Brassica rapa*

The experiment was conducted at Joydebpur, Ishurdi, Jessore, Rahmatpur and Hathazari during rabi 2019-20 with 19 genotypes of *Brassica rapa* having yellow seed coat colour along with one check as BARI Sarisha-14. The experiment was laid out in randomized complete block design with three replications. The plot size was 3m x 0.9m. Seeding was done on 26 November 2019 at Joydebpur, 6 November 2019 at Ishurdi, 6 November 2019 at Jashore, 19 November 2019 at Barshal and 26 November 2019 at Hathazari as continuous sowing in rows of 30 cm apart. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MoP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of siliquae/plant, no. of seeds/siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into kg/hectare. The data were analyzed statistically.

Nineteen lines of *Brassica rapa* having yellow seed coat colour along with BARI Sarisha-14 as check were evaluated at Joydebpur, Ishurdi, Jessore, Rahmatpur and Hathazari for seed yield and yield contributing characters. Significant variations were observed for days to maturity, number of siliquae/plant and seed /siliqua. Maturity duration ranged from 82-88 days. Plant height ranged from 75-88 cm. The lowest plant height was recorded in BC-110714(7)-7 (75 cm) after the checks. Number of siliquae/plant ranged from 25-60. The highest number of siliquae/plant was recorded in BC-110714(7)-8 (60). Number of seeds/siliqua ranged from 14-37. Seed yield ranged from 1031-1652 kg/ha at Joydebpur location.

Considering earliness, seed yield and other yield attributing characters, four lines like BC-100614 (8)–3, BC-110714 (7) -7, BC-100614 (8) -7 and BC-100614(4)-4 were selected for RYT in the next year.

Regional yield trial of *Brassica rapa*

The experiment was conducted at Joydebpur, Ishurdi, Jessore, Hathazari and Rahmathpur during rabi 2019-20. It consisted of eight advanced lines of *Brassica rapa* along with one check as BARI Sarisha-14. The experiment was laid out in randomized complete block design with three replications. The plot size was 3 m x 1.2 m. Seeding was sown on 24 November 2019 at Joydebpur, 6 November 2019 at Ishurdi, 6 November 2019 at Jashore, 19 November 2019 at Barishal and 25 November 2019 at Hathazari in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MoP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), number of siliquae/plant, number of seeds/siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha. The data were analyzed statistically.

Eight advanced lines of *Brassica rapa* along with BARI Sarisha-14 as check 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 and high performing variety of rapeseed. Significant variations were observed for seed yield at Joydebpur. Maturity duration ranged from 84-87 days. Plant height ranged from 84-97 cm. The lowest plant height was recorded in BC-100614(3)-1. Number of siliquae/plant and number of seeds/siliqua ranged from 37-60 and 23-34, respectively. The highest number of seeds/siliqua was recorded in BC-100614(8)-4. The lowest number of seed/siliqua was recorded in BS-15YF-01. Seed yield ranged from 1178-1835 kg/ha. The highest seed yield was recorded in BC-100614(4)-7 at Joydebpur location. The lowest seed yield was recorded in BS-15YF-01.

Considering earliness, seed yield and other yield attributing characters, two lines like BC-100614(8)-4, BC-120114 and BC-100614(4)-7 were selected for adaptive trials in the next year.

Evaluation of segregating generation of *Brassica juncea*

F_6 generation (Set-I)

Families of fifteen cross combinations having both brown and yellow seed coat colour were evaluated in F_6 generation (Set-I) during 2019-20 at Joydebpur. Families were sown following family to row method along with BARI Sarisha-11 as check. Seeding of fifteen crosses was done on 3 December 2019 in 3m long of 3-rows-plot with spacing 30cm and 5cm between rows and plants respectively. Single plant selection among the families was done based on erect and compact type having desirable agronomic characters, disease and insect tolerance.

F_6 generation (Set-II)

Families of six cross combinations having both and yellow black/brown seed coat colour were evaluated during 2018-19 at Joydebpur. Families were sown following family to row method along with BARI Sarisha-11 as check. Seeding of families of different cross combinations was done on 3 December 2019 in 3m long of 3-rows-plot with spacing 30cm and 5cm between rows and plants, respectively. Single plant selection among families was done based on erect and compact type having desirable agronomic characters, disease and insect tolerance.

Results

F_6 generation (Set-I)

Single plant selection method was followed. A total of 100 plants from eleven cross combinations having black/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. Two 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 twenty three families from three cross combinations having black/brown seed coat colour were evaluated and selected for further evaluation. Fourteen families from three cross combinations having yellow seed coat colour were evaluated and selected for further evaluation. 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 family were bulked. Seeds were stored for evaluation in the next year.

Observation trial of *Brassica juncea*

Thirteen lines of *Brassica juncea* along with BARI Sarisha-11 and BARI Sarisha-16 as checks were evaluated with two replications under Observation Trial of *Brassica juncea* at Joydebpur during 2019-20. The lines were sown on 25 November 2019 in 3 rows of 3m long with spacing of 30 cm and 5 cm between rows and plants respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MoP, Gypsum, zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of primary branches/plant, no. of siliquae/plant, no. of seeds/siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha.

Maturity duration ranged from 102-105 days. BJ-2014-B10 and BJ-2014-B13 were the earliest in maturity (102 days). Plant height ranged from 128-146 cm. The line BARI Sarisha -11 (ch) showed lowest plant height (128 cm). Number of siliquae/plant ranged from 76-128. Number of seeds/siliqua ranged from 9-12. Seed yield ranged from 1461-1865 kg/ha. The highest seed yield recorded in BJ-2014-B08 followed by BJ-2014-Y04. Considering earliness, seed yield and other yield contributing characters, three lines BJ-2014-B08, BJ-2014-Y04 and BJ-2014-B14 were selected for the next trial.

Preliminary yield trial of *Brassica juncea* L.

The experiment was conducted at Joydebpur, Ishurdi, Jessore and Hathazari during Rabi 2019-20. The experiment consisted of 11 lines of *Brassica juncea* having yellow seed coat colour except two along with checks BARI Sarisha-11 and BARI Sarisha-16. The experiment was laid out in randomized complete block design with two replications. The plot size was 3m x 1.2m. Seeding was done on 01 December 2019 at Joydebpur, 07 November 2019 at Ishurdi, 07 November 2019 at Jashore and 26 November 2019 at Hathazari in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MoP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of flowering. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height in cm, no. of primary branches/plant, no. of siliquae/plant, no. of seeds/siliqua, 1000 seeds weight (g) and seed yield/plot. The plot yield was converted into seed yield/hectare. The data were analyzed statistically.

Eleven genotypes of *Brassica juncea* including BARI Sarisha-11 and BARI Sarisha-16 as checks were evaluated at Joydebpur, Ishurdi, Jessore and Hathazari for yield and yield contributing characters. Days to maturity ranged from 102-104 days. Plant height ranged from 123-139 cm. Number of siliquae/plant ranged from 85-133. Number of seeds/siliqua ranged from 10-12. Seed yield ranged from 1335-1874 kg/ha. The highest seed yield was recorded in BJ-10-10104(Y).

Considering seed yield and other yield contributing characters, seven lines like BJ-10-10104(Y), BJ-2014-Y01, BJ-10-10411(Y), BJ-11536(9)-2, BJ-2014-Y05, BJ-2014-Y04 and BJ-11536(9)-6 were selected for evaluation in RYT.

Regional yield trial of *Brassica juncea* L.

The experiment was conducted at Joydebpur, Ishurdi, Jessore, Hathazari and Rahmatpur during rabi 2019-20. It consisted of 8 advanced lines of *Brassica juncea* along with one check as BARI Sarisha-11. The experiment was laid out in randomized complete block design with three replications. The plot size was 3 m x 1.8 m. Seeding was done on 1st December 2019 at Joydebpur, 7 November 2019 at Iswardi, 7 November 2019 at Jashore, 18 November 2019 at Barishal and 25 November 2019 at Hathazari in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @

120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MoP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height, no. of primary branches/plant, number of siliquae/plant, number of seeds/siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into seed yield/hectare. The data were analyzed statistically.

Eight 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. Maturity duration ranged from 101-103 days. Plant height ranged from 130-139 cm. Number of siliquae/plant ranged from 97-127. The highest number of siliquae/plant was recorded in BJ DS -05. Number of seeds/siliqua ranged from 10-12. Seed yield ranged from 940-1638 kg/ha. BJ 1110 (12)-1 produced the highest seed yield followed by BJ 1110 (12)-1 (1638 kg/ha).

Considering seed yield and other yield contributing characters, the lines BJDS -05 and BJ 1110 (12)-1 were selected for Adaptive Trial in the next year.

Observation trial of entries developed from interspecific hybridization among *B. carinata, B. rapa* and *B. napus*

The experiment was conducted with 17 accessions including two check variety Tori-7 and BARI Sarisha-13. Out of 15 accessions, 6 entries of *B. rapa* were developed crossing between the Tori-7 and *B. carinata* and 9 from the BARI Sharisha -13 with *B. carinata*. The seed was sawn on 30 December 2019. The experiment was laid out in RCB design having three replications. Each entry was grown in 3m long 3 rows. Recommended doses of fertilizer and other cultural operations were done when necessary. Data were collected from 5 randomly selected plants.

A significant difference was observed among the entries tested in the experiment for all the characters. All the selected entries developed from the crossing Tori-7 with *B. carinata* were close to the flowering compare to the check variety Tori-7. Maximum seed yield of 1518 kg/ha was obtained by the entry 1CA12014 followed by 1CA62014 (1513 kg/ha) and 1CA52014(1507 kg/ha) which were 28%, 28%, and 27% higher than the check variety Tori-7.

Days to flowering of the selected entries from the crosses between *B. napus* with *B. carinata* were almost similar to the check variety BARI Sarisha-13. But Days to maturity were reduced for all the entries than check variety. Highly significant differences were observed for all the characters. Pod per plant were higher for all the entries than check variety BARI Sarisha-13 except 13CA72014. All the 9 entries showed a higher seed yield than the check variety (1149 kg/ha). The entries 13CA32014 and 13CA12014produced the highest seed yield of 1456 and 1449 kg/ha. The BARI Sarisha-13 was an indeterminate type while the selected materials were the almost determinate type. The determinate type can reduce the shattering loss of *B. napus.*

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

The experiment consisted of two CMS lines like $CMSZ_1$ (248) and $CMSZ_2$ (279), two maintainer lines like Nap-248M and Nap-279M and one restorer line like Nap-14-01R. It was conducted at Gazipur during rabi 2018-19. Unit plot size was two rows three meter long. Seeding was done on 5 December 2019. CMS lines were crossed with maintainer lines. Maintainer lines and restorer line were selfed. Bagging was done to protect out crossing. Crossing and selfing were done by hand pollination.

Days to flowering and maturity for CMS lines ranged from 22-23 days and 98 days, respectively. In total 686 buds of 77 plants of two CMS lines were crossed with two maintainer lines. Two thousand two hundred and one seeds were obtained from 383 siliquae. Seeds were stored for future breeding programme.

Days to flowering and maturity for Nap-248M, Nap-279M and Nap-14-01R were 22-24 days and 98 days, respectively. One thousand two hundred and thirty four buds were selfed from 118 plants. In total 4504 seeds were obtained from 914 siliquae. Seeds were stored for future breeding programme.

Development of hybrid variety in rapeseed

I. Development of short duration parental lines in *Brassica napus* L.

Two CMS lines [$CMSZ_1$ (248) and $CMSZ_2$ (279)], one Restorer line (Nap-14-01R), three short duration (87-88 days) of *Brassica napus* lines (Nap-0876, Nap-0869 and Nap-205), two varieties (BARI Sarisha-8 and BARI Sarisha-13) and one *Brassica napus* line (Nap-14-015) were used as experimental materials. The experiment was conducted during rabi 2018-19 at Gazipur. Seeds were sown on 5 December 2019. CMS lines were crossed with three short duration *Brassica napus* lines, and BARI Sarisha-8 and BARI Sarisha-13. Restorer line was crossed with BARI Sarisha-8 and BARI Sarisha-13 and Nap-14-015. Bagging was done to protect out crossing. Crossing was done by hand pollination.

Days to maturity for CMS lines ranged from 96-98 days and for *Brassica napus* lines/varieties ranged from 87-95 days. One thousand four hundred and fifteen buds of 202 CMS plants were crossed with short duration *Brassica napus* lines/varieties. Four hundred and eighty eight siliquae was obtained from which 3810 seeds were obtained. Seeds were stored for back crossing in the next year.

Days to maturity for restorer line was 97-99 days and for *Brassica napus* varieties/lines ranged from 94-96 days. Four hundred and thirty two buds of 43 restorer plants were crossed with short duration *Brassica napus* varieties/lines. Two hundred and thirty one siliquae were obtained from which 1833 seeds were obtained. Seeds were stored for back crossing in the next year.

II. development of test cross hybrid in *Brassica napus* L.

CMS line [$CMSZ_1$ (248) was crossed with Restorer line (Nap-2014-01R-P_6) and CMS line [$CMSZ_2$ (279) was crossed with Restorer line (Nap-2014-01R-P_{10} to develop test cross hybrid seed. Seeds of female and male parent were sown on 5 December 2019 following 4:2 ratio. Unit plot size was twenty rows of 3m long. Netting was done to protect out crossing. Hand pollination was done for proper seed setting. The experiment was conducted at Gazipur.

Results on hybrid seeds of test crosses between $CMSZ_1$ (248) x Nap-2014-01R-P_6 and $CMSZ_2$ (2798) x Nap-2014-01R-P_{10} are days to maturity of CMS lines was 97 and 98 days and restorer lines was 101 days. Two hundred and eighty gram seeds of $CMSZ_1$ (248) x Nap-2014-01R-P_6 and 530 gram seeds of $CMSZ_2$ (2798) x Nap-2014-01R-P_{10} were obtained. Hybrid seeds of test crosses was stored for evaluation in the next year.

III. evaluation of test cross hybrids in *Brassica napus* L.

Two CMS lines, $CMSZ_1$ (248) and $CMSZ_2$ (279) were crossed with Restorer lines, Nap-2014-01R-P_6 and Nap-2014-01R-P_{10} during last rabi 2017-18 to develop test cross hybrids. Developed two hybrids were evaluated during rabi 2018-19 and 2019-20. Hybrid seeds were sown on 5 December 2019. Unit plot size was four rows of 3m long. The experiment was conducted at Gazipur.

Results on test cross hybrids, $CMSZ_1$ (248) x Nap-2014-01R-P_6 and $CMSZ_2$ (279) x Nap-2014-01R-P_{10} are days to flower was 23 and 24 days and days to maturity was 103 and 104 days, respectively for test crosses. Seed yield for hybrid $CMSZ_1$ (248) x Nap-2014-01R-P_6 was 1889 kg/ha and for hybrid $CMSZ_2$ (279) x Nap-2014-01R-P_{10} was 2028 kg/ha.

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

Two CMS lines, $CMSZ_1$ (248) and $CMSZ_2$ (279) were crossed with selected plants of Restorer line (Nap-2014-01R) during last rabi 2014-15 and 15 test cross hybrids were developed. These hybrids were evaluated during rabi 2015-16 and four test cross hybrids performed better. In order to maintain the restorer line of selected test cross hybrids, seeds of restorer lines were sown on 5 December 2019. Unit plot size was two rows of 3 m long. Selfing was done to maintain the lines. The experiment was conducted at Gazipur.

Results on selfing of restorer lines (Nap-2014-01R) of selected test cross hybrids are days to flower and maturity of selected restorer lines ranged from 22-26 days and 98-105 days, respectively. Twenty five to forty plants were selfed from each line and 195-

302 buds were selfed from which 645-998 seeds were obtained. Selfed seeds of selected restorer lines were stored for maintenance in the next year.

Days to flower and maturity of restorer line ranged from 27-29 days and 111-115 days, respectively. Six to fifteen plants were selfed from each line and 50-210 buds were selfed and 234 – 1210 seeds were obtained. Selfed seeds were stored for maintenance in the next year.

Performance of the restorer lines for the hybrid seed production

The experiment was conducted using fifteen restorer lines and one CMS line. The CMS line was grown in between two rows of each restorer line on 1 December 2019. The half seed of all the restorer lines was kept for future use. Data have been taken from randomly taken 5 plants from each accession Recommended doses of fertilizer and other cultural operations were done when necessary.

Results and Discussion

Among the fifteen restorer lines tested for the hybrid seed production, the restorer R4, R14, R1, R7, and R3 identified as strong pollen fertility restorer. The lines R16, R5, R23, and R17 showed moderate restoration of pollens, and the remaining R8, R6, R2, R15, R18, and R10 lines restoration status were weak and those will be discarded for hybrid production.

The days to flowering of the restorer lines (36-41 days) were almost synchronize with A-line (39 days).

Plant height ranged from 102-121 cm. The maximum plant height was measured in Hybrid 18 and minimum in Hybrid 8. Pod length ranged from 4.7-6.5 cm. The highest pod per plant recorded in Hybrid 17 (160) followed by Hybrid 5 (142) and lowest in Hybrid 3 (74). Seeds per pod ranged from 21-31. Seed yield ranged from 1342-2683 kg/ha. The highest seed yield was found in Hybrid 1(2683 kg/ha) followed by Hybrid 7 (2483 kg/ha) and Hybrid 18 (2400 kg/ha) and the lowest in Hybrid 8 (1342 kg/ha) followed by Hybrid 6 (1558 kg/ha).

Considering the character's fertility status, pod per plant, seed per pod, and seed yield the restorers R1, R7, R3, R23, R4, R14, R5, R17, and R16 have been selected as better restorer lines for hybrid seed production. Heterosis study of the hybrids developed with the selected restorers would be done next year with a standard variety of *B. napus.* Attempt also be taken to produce hybrid with the selected restorer.

Simultaneously the CMS line and maintainer line have been maintained through bud selfing. A total of 1503 buds were crossed from which 1146 siliquae developed. The average success of the different cross combinations was 76%.

Development of double low short duration genotypes through interspecific hybridization

I. Evaluation of F_4 generation

Parent materials of the experiment consisted of two species (*Brassica rapa* and *Brassica napus*). BARI Sarisha-17 of *Brassica rapa*, Nap-0876 and Nap-0569 of *Brassica napus* [high erucic acid (30-45%) but short duration (80-85 days)]. Nap-14-001, Nap-14-004, Nap-14-007, Nap-14-010 and Nap-14-011of *Brassica napus* [low erucic acid (less than 2%), high yielding (2.0-2.5 t/ha) but long duration (100-105 days)]. BARI Sarisha-17, Nap-0876 and Nap-0569 were crossed with Nap-14-001, Nap-14-004, Nap-14-007, Nap-14-010 and Nap-14-011 during last rabi 2015-16. Developed 15F_1s were selfed during 2016-17, 2017-18 and 2018-19 to develop F_4 generation. Developed 15 F_4s were sown on 5 December 2019. Selfing was done through bud pollination to produce F_5 generation.

Results of F_4s of 15 cross combinations of inter- and intra-specific hybridization (*Brassica rapa* x *Brassica napus* and *Brassica napus* x *Brassica napus)* are as no. of selfed plants from different cross combinations ranged from 12-46 and total 392 plants were selfed. Two thousand six hundred and fifty five buds were selfed to develop F_5 generation. Two thousand one hundred and eighty three siliqua were obtained from which 10934 seeds were obtained. Selfed seeds were stored to advance F_5 generation in the next season.

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

Five genotypes (*Brassica napus*) of double low along with BARI Sarisha-13 (*Brassica napus*) and BARI Sarisha-14 (*Brassica rapa*) as checks consisted the experiment. The genotypes were evaluated at Joydebpur, Ishurdi and Jashore during rabi 2019-20 to know the performance of the genotypes and to develop ‘double low’ (Canola) variety. The genotypes were sown on 26 November 2019 at Joydebpur, 7 November 2019 at Ishurdi and 7 November 2019 at Jashore in 3 rows of 3 m long with spacing of 30 cm and 5 cm between rows and plants, respectively. The seedlings were thinned after few days of germination 5 cm apart with three replications. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of primary branches/plant, no. of siliquae/plant, no. of seeds/siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha.

Mean performance of 5 genotypes of *Brassica napus* along with BARI Sarisha-13 and BARI Sarisha-14 as checks are variations were observed among the genotypes for days to maturity, no. of siliquae/plant and seed yield. Maturity duration ranged from 101-108 days for the genotypes of *Brassica napus*. Check variety BARI Sarisha-14 (*Brassica rapa*) was the earliest (86 days) in maturity among the genotypes. Plant height ranged from 90-117 cm. Check variety BARI Sarisha-14 showed the lowest plant height (90 cm). Number of siliquae/plant ranged from 34-71. The highest number of siliquae/plant was recorded in Nap-14007. Number of seeds/siliqua ranged from 25-31. The highest number of seeds/siliqua recorded in BARI Sarisha-14, although its yield was remarkably low. Seed yield ranged from 1446-2176 kg/ha. The highest seed yield was recorded in Nap-14011 (2176 kg/ha) and lowest in check variety BARI Sarisha -14 (ch) at Joydebpur location.

Regarding maturity duration over locations, days to maturity ranged from 86-98 days (Table 29a) and seed yield over locations ranged from 1428-1972 kg/ha (Table 29b). The line Nap-14004 produced the highest seed yield over locations.

Considering seed yield and other yield contributing characters, genotypes Nap-14004 and Nap-14011 were selected for Adaptive Trial in the next year.

Crop management

Development of seed rate for mustard-boro mixed cropping system

A field experiment was conducted at Gazipur region during rabi season of 2019-20 to find out the suitable seed rate in Mustard- Boro mixed cropping system and to calculate the cost and return of mixed cropping system. The experiment was laid out in RCB design with 3 replications. Five different treatments i.e, T_1= Boro and mustard recommended seed rate (Rice 25 kg/ha and mustard 7kg/ha), T_2= T_1+ 10% excess both of seeds of recommended seed rate, T_3= T_1+ 20% excess both of seeds of recommended seed rate, T_4= T_1- 10% less both of seeds of recommended seed rate, T_5= T_1- 20% less both of seeds of recommended seed rate. The seeds of boro rice and mustard were sown in broadcast method. At first the rice seed was sown during final land preparation, then one light pass by the tractor on the field, as the rice seed goes into the depth of the soil for delay emergence of rice seeds. After that mustard seeds were sown and laddering was done on the field. The seeds were sown on 29 November 2019 following experimental treatments. The unit plot size was 16 m^2. During fertilizer management, two-third urea and all the fertilizers of entire amount were applied during final land preparation as basal and ½ of rest of the urea was applied as top dress at 25 days after broadcasting. Remaining urea was applied after the weeding and gap filling of the rice seedling. Plant protection measure and all other management practices were done for mustard and boro rice as and when necessary. Mustard was harvested on 2 February 2020, whereas boro rice on 26 April, 2020 at Gazipur. Data on the different crop parameters were collected from the 10 sample plants and then average was taken which was further analyzed by computer program SPSS. Economic analysis was calculated to ascertain the efficiency of intercropping system. Rice equivalent yield (REY) was calculated by converting yield of component crops to the yield of rice on the basis of prevailing market prices of individual crops (Bandyopadhyay, 1984). From the evidence of research at Gazipur it was found that the highest rice equivalent yield (9.76 t ha^{-1}) was found in the treatment combination of T_4 treatment where T_1- 10% less both of seeds of recommended seed rate was applied. Cost and return analysis revealed that the T_4 treatment gave the highest gross margin (73860.00. ha^{-1}) compared to the other treatments combination. Based on the research result it revealed that boro and mustard recommended seed rate (Rice 25 kg/ha and mustard 7 kg/ha) - 10% less both of seeds of recommended seed rate might be suitable seed rate of mustard and rice in mustard boro mixed cropping system.

Development of cropping pattern for increasing cropping intensity and productivity

Field experiment was conducted at the Central Research Station of Bangladesh Agricultural Research Institute (BARI) during 2018-19 to study the comparative agronomic performance and economic return of four crops based cropping patterns. The cropping patterns were as follows: CP_1= Mustard (var. BARISarisha-16) – Indian Spinach (BARI Puisak-1) -T. aus (var. BRRI dhan55) - T. aman (var. BRRI dhan71), CP_2 = Groundnut (BARIChinabadam-8) + Spinach (Palongsakh- 2)–T.aus (var. BRRI dhan55) - T. aman (var. BRRI dhan71), CP_3=Groundnut (BARIChinabadam-8) + Red Amaranth(BARI lalsakh-1) –T.aus (var. BRRI dhan55)- T. aman (var. BRRI dhan71), CP_4 = Bushbean (BARIJharshem-1) – Sesame (var.BARI Till-4) – Kangkong (BARI Gimakolmi-1)- T. aman (var. BRRI dhan71) and CP_5= Fallow – Boro (var. BRRI dhan67) – Fallow - T. aman (var. BRRI dhan71). Four cropping patterns (CP_1, CP_2, CP_3, CP_4 and CP_5) are composed with four crops; and one cropping pattern is composed with two rice crops as control. The highest rice equivalent yield (REY) 26.50 t/ha was obtained from the cropping pattern CP_2 (Groundnut (BARI Chinabadam-8) + Spinach (Palongsakh- 2) –T.aus (var. BRRI dhan55) - T. aman (var. BRRI dhan71) followed by CP_4 (Bushbean (BARI Jharshem-1) – Sesame (var.BARI Till-4) – Kangkong (BARI Gimakolmi-1)- T. aman (var. BRRI dhan71). Due to growing four crops in year in the same piece of land more employment opportunity for male and female labours could be created and at the same time due to increased production of rice, sesame, Indian spinanch, spinanch, redamaranth, bushbean, groundnut and mustard the food security and nutritional security could be ascertained for the farmers at same time cropping intensity and productivity could be increased.

Insect pest management

Development of a management approach against flea beetle attacking mustard

The experiment was conducted to record the incidence of flea beetle in mustard and to estimate damage severity of the pests in mustard varieties during robi season 2019-20 at ORC research field, BARI, Gazipur and Regional Agricultural Research Station, Jashore. The experiment is done with three replication following RCBD. The treatments were as follows: T_1= White sticky trap + Bio-clean (D-Lemonine SL) @1.0 ml/L of water, T_2= White sticky trap+ Spraying of Biotrine @ 0.5ml/L of water, T_3= White sticky trap+ Spraying of Spinosad (Success 2.5 SC) @ 1.2 ml/ L of water , T_4= Spraying of Nitro @ 1.0 ml/L of water, T_5= Untreated control. The maximum reduction of plant infestation over control was found in T_1 treated plot (55.86%). The highest yield was found in T_1 treated plot (1.50 t/ha) and the lowest in T_5 control plot (0.85 t/ha).The best MBCR was found in treatment package 1.

Groundnut (*Arachis hypogaea* L.)

Varietal improvement

Maintenance and evaluation of groundnut germplasm

A total of 237 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 18 December, 2019. Seeds were sown in two rows of 4 m long plot with the spacing of line to line 30 cm 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 237 groundnut germplasm accessions were evaluated at Joydebpur, Gazipur. The ranges for days to 1st flowering, days to maturity, plant height, mature pods/plant,100-kernel weight (g), shelling % and plot yield were 58-72 days, 138-152 days,22-47cm, 11-50, 30-65, 50-79 and 595-3500 kg/ha respectively. The highest coefficient of variation (CV %) was recorded for the character plot yield (29.48%). Minimum variation was observed in the character days to maturity. The seeds of the germplasm will be grown in the next year and stored for using in the future breeding program.

Creation of genetic variability of groundnut through hybridization

A total of 261 buds were pollinated at Joydebpur. Average cross success was 50% and produced 132 pods. The pollinated pods will be grown in the next Rabi season for F1 confirmation. Two batches of four parental lines were sown on ten days interval in 22 December, 2019 and 01 January, 2020 at Joydebpur. The seeds of individual parents were planted in raised bed of 2 rows x 4 m long with the spacing of 50 and 20 cm 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 3.00 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 cross combinations from F1, 22 entries from F2, 12 entries from F3, 8 entries from F4, 4 entries from F5 and 3 entries from F6 respectively were sown on December 17, 2019 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 25, 103, 54 , 37, 20 and 15single plants were selected from F1, F2, F3, F4, F5 and F6 generations respectively. The seeds from selected single plants of F1 were collected and stored for advancing the generation as F2 in the next season. On the other hand, the seeds from selected plants of F2 were collected and stored according to the cross and generation will be advanced as F3 generation. From the F3 generation 54 plants were selected from 12 accessions and will be tested their performance as F4 generation in the next season. From the F4 generation 37 plants were selected from 8 accessions and will be tested their performance as F5 generation in the next season.From the F5generation 20 plants were selected from 4 accessions and will be tested their performance as F6 generation in the next season. From the F6 generation 15 plants were selected from 3 accessions and will be tested their performance as observation trial in the next season.

Observation trial of groundnut

Seventeen genotypes including two checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur during rabi 2019-20. Seeds were sown on 17 December, 2019 in RCB design with three 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 N P K S Zn B, respectively.

Maximum shelling percent were found in the genotypes Galachipa (74%) and ICGVS SL-1 (70%) and higher values for the characer were found in the Galachipa, ICGVS SL-1, BARI Chinabadam-8 and Dhaka-1. Highest pod yield of 2830 kg/ha was obtained from the genotype ISD 0414 followed by the genotype ISD 2914(2750 kg/ha), Choko 0314(2700 kg/ha), Galachipa (2450 kg/ha), Jhaldhaka (2416 kg/ha), ICGVS 38-3(2396 kg/ha), BDGV 702-6-2-1(2381 kg/ha) and BDGV 14-103(2373 kg/ha) which were 20%, 16%, 14%, 4%, 2%, 1%, 1% and almost 1% higher than the check variety BARI Chinabadam-8, respectively. Maximum mature pods per plant was observed from the entry ISD 0414 (36).Highest 100 kernel weight 63g was obtained from the genotype ISD 0414. Considering the pod yield eight genotypes ISD 0414, ISD 2914, Choko 0314, Galachipa, Jhaldhaka, ICGVS 38-3, BDGV 702-6-2-1 and BDGV14-103 have been selected for PYT.

Preliminary yield trial of groundnut

The experiment was conducted with seventeen groundnut genotypes including 2 checks as Dhaka-1 and BARI Chinabadam-8 at Joydebpur in a randomized complete block design with 3 replications. Unit plot size was 6 rows 4m long with the spacing of 40 cm between rows and 15 cm between plants. Recommended doses of fertilizers were applied @ 80:65:60:20:4 kg/ha of NPKS Zn, respectively.

Significant differences were observed among the genotypes for all the characters except days to 1stflowering and days to maturity studied at Joydebpur. Maturity duration ranged from 144-149 days. Highest number of mature pods/plant (41) was obtained by the entry ISD 3814. The range of hundred kernel weight was 34-65 g. Highest shelling percentage was recorded in the genotype TG-51 (78%). The Genotype ISD 3814 produced the maximum pod yield (2843 kg/ha) followed by ICGV 93420 (2786 kg/ha), ICGV 95090(2777 kg/ha), ICGVS 35-1(2736 kg/ha), ISD 4114(2639 kg/ha), ICGV 02841 (2523 kg/ha), NCGV 0207(2516 kg/ha), NCGV 0704(2483 kg/ha) and TG 37(2403 kg/ha) which were 22%, 20%, 19%, 18%, 13%, 8%, 8%, 7%, and 3% higher than the check variety BARI Chinabadam-8 respectively. Nine genotypes ISD 3814, ICGV 93420, ICGV 95090, ICGVS 35-1, ISD 4114, ICGV 02841, NCGV 0207, NCGV 0704 and TG 37 have been selected for Regional Yield Trial.

Regional yield trial of groundnut (Set-1)

The experiment was conducted at Joydebpur during Rabi 2019-20 with 16 promising genotypes of groundnut including 3 checks Dhaka-1, BARI Chinabadam-8 and BINA Chinabadam-4. The experiment was laid out in Randomized Complete Block design having three replications. The plot size was 4 m x 2 m. Spacing was 15cm seed to seed and 40 cm row to row. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MoP, Gypsum and Boric acid.

Significant differences were observed among the genotypes for all the characters studied at Joydebpur. Maturity duration ranged from 144-149 days. Highest number of mature pods/plant (46) was obtained from the entry ICGV-07219.The range of hundred kernel weight 38-54g. Highest shelling percentage (75) was recorded in the genotype ICGV-05158 and ICGV-06237. The genotype ICGV-07219 produced the maximum pod yield (2690 kg/ha) followed by ICGV-06423 (2599 kg/ha), ICGV-06285 (2493 kg/ha), ICGV-05158 (2450 kg/ha), ICGV-91114 (2330 kg/ha) and ICGV-06237 (2286 kg/ha) which were 18%, 14%, 9%, 7%, 2% and 1% higher than the check variety BARI Chinabadam-8. Five genotypes ICGV-07219, ICGV-06423, ICGV-06285, ICGV-05158 and ICGV-91114 have been selected for Adaptive Trial.

Regional yield trial of groundnut (Set-2)

Twelve entries including two checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur. Unit plot size was 6 rows 4 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.

Significant differences were observed among the genotypes for all the characters except mature pods/ plant studied at Joydebpur. Maturity duration ranged from 144-149 days. Highest number of mature pods/plant (37) was obtained by the entry NCGV-04096. The range of hundred kernel weight 34-62g. Highest shelling percentage was recorded in the genotype ICGV-01080 (75%).The Genotype NCGV 04096 produced the maximum pod yield (2690 (kg/ha) followed by ICGVS 36-1(2660 kg/ha), ICGV-02096(2410 kg/ha) and NCGV-0504 (2393 kg/ha) which were 17%, 16%, 5% and 4% higher than the check variety BARI Chinabadam-8. Four genotypes NCGV 04096, ICGVS 36-1, ICGV-02096 and NCGV-0504 have been selected for Adaptive Trial.

Crop management

Intercropping fenugreek with groundnut

A field experiment of intercropping fenugreek with groundnut was conducted in Oilseed Research Centre, BARI, Gazipur during rabi season of 2019-20 to find out the optimum row arrangement of fenugreek as intercropping with groundnut for higher productivity and return. Five treatments were T_1 = One row of fenugreek (15 cm × 10 cm) in between two normal rows of g.nut (40 cm × 15 cm), T_2 = Two rows of fenugreek in between two normal rows of g.nut, T_3 = Two g.nut rows alternate with two rows of fenugreek, T_4= Fenugreek broadcast in between two normal rows of g.nut (40 cm × 15 cm), T_5= Sole groundnut and T_6 = sole fenugreek. The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 4m x 5m. Both the seeds of groundnut (BARI Chinabadam-8) and fenugreek (BARI Methi-1) were sown on 3 December, 2019. Fertilizers at the rate of $N_{12}P_{31}K_{43}S_{55}B_{1.5}$ kg/ha in the form of urea, TSP, MOP, gypsum and boric acid, respectively were applied for both sole groundnut & intercrop. Full amount of triple super phosphate, muriate of potash (MoP), gypsum, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied 40 days after seedling emergence. On the other hand, for sole fenugreek, fertilizers at the rate of $N_{80}P_{34}K_{68}S_{20}$ kg/ha in the form of urea, TSP, MoP, gypsum, respectively were applied. Full amount of triple super phosphate, muriate of potash and gypsum and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied at 30 days after sowing (DAS). At harvest, the yield data was recorded plot wise. Collected data were analyzed statistically and means were adjusted by LSD test at 5% level of significance using SPSS. Yield of individual crop was converted to groundnut equivalent yield (GEY) considering prevailing market price of the crops. Marginal benefit cost analysis was also done. Although intercropping reduced groundnut yield but total productivity was increased due to addition of fenugreek yield. Total productivity in terms of groundnut equivalent yield (GEY) (2.99 t/ha) was found maximum in T_2 (Two rows of fenugreek in between two normal rows of ground nut) treatment while the lowest (1.25 t/ha) in fenugreek sole crop. Maximum benefit cost ratio (BCR) (4.50) was also recorded in T_2 treatment (Two rows of fenugreek in between two normal rows of g.nut). It was revealed that two rows of fenugreek in between two normal rows of groundnut would be agronomically feasible and economically profitable for the farmers in intercropping system.

Effect of seed priming on seed quality of groundnut

The seeds of groundnut variety BARI Chinabadam-8 was subjected to seven seed priming treatments namely T_1- Control (No priming), T_2- seeds soaked in water for the period of 6 hr followed by shade drying, T_3- seeds soaked in water for the period of 12 hr followed by shade drying, T_4- seeds soaked in 1% boron solution for the period of 6 hr followed by shade drying, T_5- seeds soaked in 1% KCl solution for the period of 6 hrs followed by shade drying, T_6- seeds soaked in 1% GA_3 solution for the period of 6 hrs followed by shade drying, and T_7- seeds soaked in 1% $CaCl_2$ solution for the period of 6 hrs followed by shade drying,. The experiment was conducted at the laboratory of Oilseed Research Centre, BARI in Randomized Block Design with three replication. Prior to the experimentation, about 10 grams of each salt were dissolved in one litre of distilled water to prepare 1 per cent concentration solutions in sufficient quantities for seed soaking purpose. Subsequently seeds were soaked in respective salt concentrations in 1:5 ratios for 6 or 12 hours. Further they were decanted and surface dried for their original weight. The soaked seed and dried seed were utilized for this experiment. Among all the seed priming treatments, seed priming with soaking in water (osmo priming) was found to be the best priming treatment followed by priming using GA_3. Among all seed priming treatments soaking the seed for 12 hrs in water having more pronounced effect on germination behavior and vigour in groundnut seeds.

Soybean (*Glycine max* L)

Variety development

Maintenance and evaluation of soybean germplasm

A total of one hundred fifteen germplasms were grown in a non-replicated trial at Gazipur to evaluate the materials for future use in the breeding program. The sowing date was 30 December 2019. Seeds were sown in two rows of 4 m long plot with the spacing line to line 40 cm and plant to plant 10cm. Fertilizers were applied @ 25:35:55:18 kg per ha of NPKS, respectively from Urea, TSP, MoP, and Gypsum.

The ranges for days to flowering, days to maturity, plant height, pods per plant, seeds per plant, hundred seed weight and branches per plant were 51-85 days, 98-160 days, 15-75 cm, 2-72, 2-3, 4-26 gm and 1-7 respectively. The percent highest coefficient of variation (CV%) was recorded for the character pods per plant (47.3) followed by branches per plant (42.3) and hundred seed weight (35.3) respectively. Minimum variation was observed in the character days to flowering, days to maturity, and seeds per pod. The character plant height showed moderate variation.

Observation trial of soybean

Eleven entries including one check variety namely BARI Soybean-6 were evaluated in an RCBD design with two replications for seed yield and it's components at Gazipur, during rabi 2019-20. The unit plot size was 2 rows of 4 m long and the spacing was maintained 40 cm between rows and 10 cm between plants. The sowing date was 30 December 2019. Fertilizers were applied @ 25:35:55:18 kg per ha of NPKS respectively, from Urea, TSP, MP, and Gypsum. 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 per plant, and 100 seeds weight (SW) were recorded from 5 randomly selected plants of each plot. Recorded data were analyzed statistically.

Statistically, a significant difference was observed among the entries for all the characters studied. The entry B2 required minimum days to mature (109) while USDA 90, USDA 40, and USDA 53 took maximum days to mature (121-128). The highest plant height was recorded for USDA 95 and B2 (58 and 57 cm). The most dwarf entry was VIETKHAI (39 cm). The entry USDA 53 produced the highest pods per plant (52). The entries USDA 53, USDA 107, and USDA 40 produced 11%, 6%, and 2% higher yield compared to the check variety BARI Soybean-6.

Preliminary yield trial of soybean

Nine entries including one check variety viz. BARI Soybean-6 was evaluated in an RCB design with three replications for seed yield and it’s component at Gazipur and Cumilla during 2019-20. The unit plot size was 4 rows of 4 m long and the spacing was maintained 40cm $\times$ 10cm apart. The sowing date was 30 December 2019 at Gazipur. Fertilizers were applied @ 25:35:55:18 kg per ha of NPKS, respectively from Urea, TSP, MoP, and Gypsum. The yield contributing characters were recorded from 5 randomly selected plants of each plot. Seed yield was converted into kg per ha. Recorded data were analyzed statistically.

A significant difference was observed for yield and yield contributing characters at Gazipur location. The entry GMOT 13 was the most dwarf (37 cm) while USDA 44 and USDA 72 showed maximum plant height (59 and 54 cm). The maximum number of pods per plant (44) was found in the entry USDA 72 while the minimum number in USDA 95 (8). The entries USDA 53, USDA 72, and USDA 4 were produced the higher seed yield compared to the check variety BARI Soybean-6. The entry USDA 95 took maximum days to mature (127) and USDA 4 took 108 days to mature which was minimum.

Regarding the multi-location trial, statistically significant difference was observed among the entries for yield. Yield ranged from 2077-2678 kg/ha. USDA 95 produced the highest yield (2678 kg/ha) followed by USDA 44 (2443 kg/ha) which were 29% and 18% higher than the check variety BARI Soybean-6.

Regional yield trial of soybean

Eight entries including two check varieties viz. BARI Soybean-5 and BARI Soybean-6 were evaluated in an RCB design with three replications for seed yield and it’s component at Gazipur, Cumilla, and Burirhat. The unit plot size was 6 rows of 4 m long and the spacing was maintained 40 cm $\times$ 10 cm apart. The sowing date was 30 December 2019 at Gazipur. Fertilizers were applied @ 25:35:55:18 kg per ha of NPKS, respectively from Urea, TSP, MoP, and Gypsum. 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.

At Gazipur location, SANTAROSE was the most dwarf (34 cm) while AGS 79 and AGS 95 were the tallest (55 cm) in plant height. Maximum no. of pods per plant (48) was found in the entry KHSH 2004 while the minimum number in LG-92P-11-76 (8). The highest seed yield was obtained by the entry SANTAROSE (1975 kg/ha) followed by GMOT 17 (1924 kg/ha) which were 12% and 9% higher than the check variety BARI Soybean-6 (Table 4). The entry LG-92P-11-76 took the maximum days to mature (127) while the check variety SANTAROSE took 106 days to mature.

In multi-location trial, yield ranged from 1346-2809 kg/ha. Among the entries, SANTAROSE produced the highest yield (2809 kg/ha) which was 56% higher than the check variety BARI Soybean-6. Statistically significant difference was observed among the entries for yield.

Insect management

Development of a management package against major insect pests of soybean

The experiment was conducted to determine the best management package for the control of insect pests of soybean and to avoid the indiscriminate use of insecticides for controlling insect pest of soybean during Rabi 2019-20 season at ORC research field, BARI, Gazipur. The experiment is done with three replications following RCBD. The treatments were as follows: T_1 (IPM Package 1) = Hand picking of larvae + Perching + Sex pheromone mass trapping of Spodoptera litura+ Application of Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water, T_2 (IPM Package 2) = Hand picking of larvae + Perching + Sex pheromone mass trapping of Spodoptera litura + Application of SNPV @ 2 g/10 litre of water, T_3 (IPM Package 3) = Hand picking of larvae + Perching + Sex pheromone mass trapping of Spodoptera litura+ Bio-chamak (Celastras angulatas 1% EW) @ 1.0 ml/litre of water, T_4 = Farmers practice (Application of virtako 40 WG @ 0.5g/litre of water), T_5 = Untreated control. The highest number of aphid, jassid, whitefly, thrips, hairy caterpillar and leaf roller was found in control plots and the lowest in IPM Package 3. The highest yield was found in IPM package 3 (1.90 t/ha) and the lowest in control plots (0.95 t/ha).The highest MBCR was also calculated from IPM package 3.

Screening of soybean entries against leaf roller and hairy cattterpillar under natural field condition

The experiment was conducted to find out the resistant entries against leaf roller and hairy caterpillar to record the incidence of target pests in different soybean entries during Rabi 2019-20 season at ORC research field, BARI, Gazipur. The experiment is done with three replication following RCBD. Seventeen (17) entries of soybean were evaluated against leaf roller and hairy caterpillar infestation during 2018-19 at ORC, BARI, Gazipur. Of these, 05(five) entries namely BOOS, GMOT-95, SANTAROSE, USDA-95, VIETKHAI were selected for comparatively less infestation by leaf roller and hairy caterpillar than the other entries and check varieties.

Sunflower (*Hellianthusannus*L.)

Varietal improvement

Collection evaluation and maintenance of sunflower

Forty-three sunflower accessions were grown at the research field of ORC, BARI Gazipur on 2nd December 2019. BARI Surjamukhi-2 was used in this experiment as a check. 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, MoP 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 ranges for days to flower, days to maturity, plant height (cm), stem diameter (cm), head diameter (cm), number of seeds/ heads, seed yield/head (g) and 100 seeds weight (g) were 63-87, 90-139, 42.4 -157.0 cm, 0.72 -2.12 cm, 8.6-20.6 cm, 50-436, 2.0-20.20 and 4.0-9.0 g, respectively. The highest CV% was recorded for the character number of seeds/head (62.4) followed by seed yield/head (59.1). Minimum variation was observed for the characters days to flowering and days to maturity

Development of dwarf inbred lines in sunflower:

Advancing S_5 to S_6 generations

Seeds from one hundred and fifty S_5 single head of nine sunflower genotypes were grown at ORC research field, BARI, Gazipur during rabi season 2019-20. Seeds were sown on 2nd December 2019 followed head to row method of 4 m long plot where the spacing was 50 cm between the rows and 25 cm between the plants. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MoP, 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 were done properly to prevent out crossing. Pollen were collected and rubbed within the same head by hand brush during selfing. Data was recorded on average plant height (cm), head diameter (cm), seeds/head and seed weight/head (g).

A total of 2119 heads of nine sunflower genotypes were selfed. Number of plants selected and the average plant height, head diameter, seeds/head and seed weight/head of selected plants were recorded. As the objective of this study was to develop dwarf inbred lines of sunflower, based on plant height a total of five hundred and eight single plants were selected out of 2119 selfed plants from nine sunflower genotypes. In this year most of the plants in each genotype showed more or less homogeneity in height. Therefore, the plants in each genotype with closer height were selected and bulked, and will be grown as family in the next rabi season.

Identification of parental lines for development of hybrid variety in sunflower

S_4 seeds of CN001, CN002, CN003 and S_6 seeds of Hysun-33 were used as experimental material in this experiment. Seeds were sown on 05 December 2019 in ORC research field in two rows of 4 m long with the spacing of 50 cm between the rows and 25 cm between plants. 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 selfed. Data on total number of plants, number of pollen fertile plants, and number of CMS plants were recorded.

Self-fertilized plant or a cross between a CMS plant and a pollen fertile plant of hybrid CN001, CN002, and CN003 could not produce 100% fertile or CMS plant. Therefore, further investigation is needed to find out a fertility restorer or CMS maintainer plant.

Some self-fertilized or cross between a pollen fertile and CMS plant of hybrid Hysun-33 produced 100% fertile plant which might indicated that these would be a restorer plant of that hybrid but none of the self-fertilized or cross between a pollen fertile and CMS plant of hybrid Hysun-33 could produce 100% sterile plant. Further investigation is therefore needed for getting a maintainer or restorer plant of this hybrid.

Development of synthetic and composite sunflower variety

i) Development of synthetic sunflower variety

Four sunflower inbred lines (P1: P-S-2-OP1, P2: P-S-2-OP3, P6: P-S-2-OP2, and P8: P-S-2-OPb) which were selected as good general combiner in the 2018-19 rabi season, were grown at the research field of ORC, BARI Gazipur on 2nd December 2019. Seeds of each four entry were sown in 16 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, MoP 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. Each four row from each entry were used to develop self, cross or reciprocal cross seeds. Pollen was collected and all possible crosses (both cross and reciprocal cross) were made between the inbred rubbing pollen using soft brush. A number of plants also were selfed to maintain the inbred lines. The number of heads selfed, cross or reciprocal cross and total amount of seed obtained from selfing, crossing or reciprocal crosses were recorded.

At maturity seeds from each cross, reciprocal cross and self-plant were harvested and kept separately. Equal amount of seed from each cross and reciprocal cross will be mixed and will be grown as Syn-1 in the next rabi season and will be evaluated for yield and yield contributing traits.

ii) Development of composite sunflower variety

The seeds from composite-3 were grown at the research field of ORC, BARI Gazipur on 19 November 2019. Seeds were sown in 770 m^2 plot, maintaining row to row distance 50 cm and plant to plant distance 25 cm. The inbreds were allowed to intermate by open pollination in isolation. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MoP 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 seed weight (g). The plants were harvested in bulk as composite-4 and kept for growing as composite-5 in the next rabi season.

Development of dwarf high yielding sunflower variety through induced mutagenesis:

i) Evaluation of M4 mutants created by gamma radiation

Gamma radiation treated M4 seeds of sunflower variety BARI Surjamukhi-2 were used in this study. All the M4 seeds (obtained from rabi season 2018-19) along with a total of 150 non-irradiated seeds were sown at the research field of ORC, BARI Gazipur on 1st December, 2019 to generate M4 population. The seed were grown in 4 m long plot maintaining 50 cm × 25 cm row to row and plant to plant distance, respectively.

Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MoP 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-dressing during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth. Plot of each treatment was covered with nylon net to prevent outcrossing and selfing was done within the treatment. The entire M4 populations were grouped into tall (plant height above 120 cm), medium dwarf (plant height between 100-120 cm), and dwarf (plant height less than 100 cm) compared to the non-treated plants. The note on plant architecture such as big-headed mutant (head diameter greater than 17 cm), branched mutants (more than one head) and robust stem girth (stem diameter thicker than 1.5 cm) also were taken in this study as important criteria. Mature heads of each group were harvested separately and kept for growing as M5 generation in the next rabi season.

A total of 152 single head from medium dwarf, dwarf, tall mutants were harvested and kept separately and will be grown and evaluated as M5 mutants in the next rabi season.

Molecular characterization of sunflower dwarf mutants by the expression analysis of *ent-kaurenoic acid oxidase* (*HaKAO*) gene sequence

The total RNA was extracted from EMS and gamma rays mutated dwarf sunflower mutant and its non-treated one, and first strand cDNA was derived from total RNA in 2018-19. To analyze ent-kaurenoic acid oxidase gene, two gene specific primers (*HaKAO1* and *HaKAO2*) and one housekeeping gene (*Haβ-actin)* primer pairs were used according to Fambrini *et al*., 2011. Another KAO1 (*Hamutdw1*) primer pairs were designed using primer 3 plus software and synthesized from a gene sequence of Helianthus annuus mRNA ent-kaurenoic acid oxidase (Gene Bank accession number FR666915) obtained from Gene Bank.

Primers were designed to yield a 223, 238, 243 and 183 bp fragments for *HaKAO1*, *HaKAO2, Haβ-actin* and *Hamutdw1*, respectively.

Independent RT-PCR was performed using aliquots of 1 µl cDNA samples. The PCR conditions were follows as: one cycle at 95 °C for five minutes, followed by 30 cycles at 95 °C for 30 sec, 55 °C-58°C for 30 sec, 72 °C for one minute followed by an additional cycle of five minutes at 72 °C. The PCR products were separated on 2.0 % TAE agarose gel and viewed under UV light.

Semi-quantitative RT-PCR analysis revealed that all KAO genes were expressed in different organs of EMS treated dwarf sunflower plant (Fig 1). Expression levels of different ent-kaurenoic acid oxidase gene in different tissues thus suggesting that KAO genes might play an important regulating role in transcription level in GA biosynthesis of the dwarf sunflower.

Creation of mutant sunflower through EMS: evaluation of M3 mutants

EMS treated (0.6% EMS treated) M3 seeds of sunflower variety BARI Surjamukhi-2 (obtained from rabi season 2018-19) were sown in head to row method at the research field of ORC, BARI Gazipur on 1st December, 2019 to generate M3 population. Along with a total of 150 non-treated seeds were also sown. The seed were grown in 4 m long plot in required number of rows maintaining 50 cm × 25 cm row to row and plant to plant distance, respectively.

Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MoP 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-dressing during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth. Plot of each treatment was covered with nylon net to prevent outcrossing and individual head was self-fertilized using hand pollination by rubbing the head.

The entire M3 populations were grouped into tall (plant height above 120 cm), medium dwarf (plant height between 100-120 cm), and dwarf (plant height less than 100 cm) compared to the non-treated plants. The note on plant architecture such as big-headed mutant (head diameter greater than 17 cm), branched mutants (more than one head) and robust stem girth (stem diameter thicker than 1.5 cm) also were taken in this study as important criteria. A total of 90 single head from medium dwarf, dwarf, tall mutants were harvested and kept separately and will be grown and evaluated as M4 mutants in the next rabi season.

Crop management

Effect of different spacing on newly released dwarf type sunflower variety

The experiment was conducted at the research field of Oilseed Research Centre (ORC), BARI, Gazipur during the rabi season of 2019-2020 to identify the suitable plant to plant and row to row spacing of newly developed sunflower variety in Bangladesh. There were four treatments viz. T_1: 40 x 20 cm, T_2: 40 x 25 cm, T_3: 50 x 20 cm and T_4: 50 x 25 cm (recommended spacing). The crop variety was BARI Surjamukhi-3. The experiment was design in RCB with three replications. Seeds were sown in 3 December 2019 with a plot size was 3m x 4m. Fertilizers were applied at the rate of $N_{88}P_{34}K_{80}S_{28}Zn_3B_2$ kgha^{-1} in the form of urea, TSP, MoP, gypsum, zinc oxide and boric acid, respectively. Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied in equal amounts at 30 & 55 days after sowing (DAS). Two times irrigation at 30 & 70 days after sowing were applied during the growing period.. At every one month interval plant samples were collected to measure the SPAD value, light interception data and dry weight content. Percentage oil content was estimated for each treatment after harvesting the crop. Seed yield (1.95 t/ha) was recorded highest in T_3: 50 x 20 cm which was higher than rest of the treatments but statistically similar to T_4: 50 x 25 cm.

Effect of fertilizer doses on newly released dwarf type sunflower variety

Accurately quantifying the optimum fertilizer rate is essential to maximize profitability and minimize potential negative environmental impact. An experiment was conducted at the Oilseed Research Centre (ORC), BARI, Gazipur during the rabi season of 2019-2020 to identify the suitable fertilizer doses for newly developed sunflower variety of ORC. There were five treatments viz. T_1: recommended dose (RD), T_2: 20% less than RD, T_3: 20% more than RD, T_4: 30% more than RD and T_5: 40% more than RD. The experiment was laid out in RCB design with three replications. Seeds were sown in 03 December 2019 at Gazipur with a plot size of 3 m x 4 m. Fertilizers were applied as per treatment combinations in the form of urea, TSP, MoP, gypsum, zinc oxide and boric acid, respectively where full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied in equal amounts at 30 & 70 days after sowing (DAS). Two times irrigation at 30& 70 days after sowing were applied during the growing period. Plant samples were collected at every one month interval starting from 20 DAS to measure the leaf area, and dry weight content. Percentage oil content was estimated for each treatment after harvesting the crop. Data on yield and yield contributing characters were recorded and analyzed statistically using SPSS program. Seed yield was recorded highest in T_4 (1.97) which might be due to higher number of seed per head, 100-seed weight and head diameter and it was statistically identical with T_5 (1.92). It was revealed that 30% more than recommended fertilizer (RD) dose may be optimum for BARI Surjamukhi-3followed by 40% more use of fertilizer than RD.

Effect of different irrigation level on dwarf type sunflower variety

The experiment was conducted at the Oilseed Research Centre (ORC), BARI, Gazipur during the rabi season of 2019-2020 to identify the suitable irrigation management for newly developed dwarf sunflower variety BARI Shurjomukhi-3. There were five treatments viz. T_1: Irrigation as and when necessary, T_2: Irrigation at vegetative and flowering stage, T_3: Irrigation at vegetative and seed development stage, T_4: Irrigation at flowering and seed development stage and T_5: Irrigation at vegetative, flowering and seed development stage. The crop variety was BARI Surjamukhi-3. The experiment was design in RCB with three replications. Seeds were sown in 3 December 2019 at Gazipur with a plot size of 3m x 4m. Fertilizers were applied at the rate of $N_{88}P_{34}K_{80}S_{28}Zn_3B_2$ kgha^{-1} in the form of urea, TSP, MoP, gypsum, zinc oxide and boric acid, respectively. Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied in equal amounts at 30 & 55 days after sowing (DAS). Irrigation was appled according to the treatment requirement. Plant samples were collected at one month interval starting from 20 DAS to measure the LAI (leaf area index), and total dry weight content. Percentage oil content was estimated for each treatment after harvesting the crop. Data on yield and yield contributing characters were recorded and analyzed statistically using SPSS program. The maximum seed yield (2.0t/ha) was recorded in T_1 treatment (Irrigation as and when necessary) which was statistically similar to T_5 treatment (Irrigation at vegetative, flowering and seed development stage).

Effect of different storage containers on the seed quality of sunflower

Experiment was carried out at Oilseed Research Centre, BARI, Gazipur during the period 2019-20 to evaluate the suitable storage container or polythene bag of different diameter for sunflower seed preservation and to find out the effect of storage period on the seed quality of sunflower under ambient condition storing. The experiment was laid out in Factorial Complete Randomized Design (CRD) with three replications. Plastic container and polythene bag of different diameter (0.02, 0.04, 0.06, 0.08, 0.10 mm) were used in this experiment. Experiments were conducted for six months (from December to May). Results revealed that plastic container and polythene bag having 0.06-0.10 mm thickness were found less permeable to moisture transmission compared with polythene bag having 0.06-0.10 mm thickness. Thicker diameter polythene bag showed the maximum germination capacity with high germination percentage and vigour index; whereas thinner polythene bag showed the lowest seed germination capacity during the testing period. The highest moisture content and abnormal seedlings were recorded in thinner polythene bag; whereas the lowest values of these parameters were recorded in plastic container. The moisture content and abnormal seedlings were increased with advanced of storage period. Germination percentage, vigour index, oil content in seed was decreased with the increase of storage periods. Among the six containers, plastic container and polythene bag with 0.06-0.10 mm diameter were the best storage container/bag for sunflower seed storage for long time.

Disease management

In vitro study on the efficacy of different isolates of bio-control agent against *Sclerotium rolfsii* causing collar rot of sunflower

A lab experiment was conducted at Pathology Laboratory of Oilseed Research Centre, BARI, Joydebpur during 2019-2020 to test efficacy of biocontrol agents against sclerotium rolfsii through duel culture technique. Seven biocontrol agents viz .Tricoderma harzianum (HRC)T. hargianum (ThL001), T. hargianum (THB001), T. viride (TVO1), T.hargianum (THP01), Bacillus subtilis, and Pseudomonus fluorescens were evaluated against Sclerotium rolfsii causing collar rot disease of sunflower. After 72 hrs inoculation Tricoderma harzianum (THB001) (70%), Tricoderma harzianum (ThL001) (65%), Tricoderma harzianum (HRC) (64%), Tricoderma harzianum (THP01) (63%) Tricoderma harzianum (TVO1)) (59%), Bacillus subtilis (58%), and Pseudomonas florescens (53%) inhibited the mycelial growth of Sclerotium rolfsii. Tricoderma harzianum (THB001).Tricoderma harzianum (ThL001) and Tricoderm aharzianum (HRC) were found more effective antagonists than Bacillus spp and Pseudomonas florescens against mycelial growth of S. rolfsii under in vitro condition. From the experiment it may concluded that effective bio control agent *Trichoderma spp*. and *Bacillus spp*. could be used in reducing the soil borne pathogens (Sclerotium rolfsii) in the field of sunflower to manage collar rot disease.

Collection, isolation & morphological characterization of *Sclerotium rolfsii* isolated from sunflower in coastal area of bangladesh (PhD Programe)

Twenty (20) different pathogenic isolates of Sclerotium rolfsii were collected from infected samples of sunflower from various sunflower growing areas in southern areas of Bangladesh. The morphological studies on the pathogen showed variation among different isolates. Variations were observed in colony morphology, mycelial growth, sclerotium formation, sclerotial size, colour sclerotial arrangement and number of sclerotia. The maximum (1.45 mm/hr) mycelial growth recorded in Isolate -16 (DKHASr - 2) followed by Isolate – 9 (1.34 mm/hr) among the 20 isolates. The minimum mycelial growth (0.99 mm/hr) was yielded in Isolate 20 (GAHASr -2)). The colony appearance and growth pattern of isolates 3, 5, 10, 13, 15, 16, 17, 18, 19 and 20 exhibited compact and thick consistency. Wooly colony consistency were found in isolate 6,7,11 and 14. In other isolates the colony consistency was Fluffy and thick. Number of sclerotia produced by different isolates on culture plates varied 377-986 per plate. The highest number of sclerotia was produced by isolate-15 (986/plate) followed by Isolate - 2 (853/plate). The lowest number of sclerotia was produced by isolate -7(377/plate). However, the sclerotial colour ranged from light to dark brown, and their size varied from 0.97-1.1 mm in diameter with round to irregular shape. The test weight of 100 sclerotial bodies ranged between 47-59 mg.

Findings of the present studies reveal that most of the morphological characteristics of the cultures of *S. rolfsii* isolated from collar rot infected sunflower plants were varied. Based on those variations in morphological characteristics, the 20 isolates demonstrate that these were independent isolates.

Insect management

Survey on the insect pests of sunflower and documentation of their natural enemies

This experiment is conducted to record the insect pests of sunflower with their natural enemies and to estimate the extent of damage by the major insect pests of sunflower. Thirty species of insect pests were found to infest sunflower crop at their different growth stages during Rabi 2019-20 season at ORC research field of BARI, Gazipur. Among the recorded pest species, six insect species namely, hairy caterpillar, *Spilarctia oblique*; common cutworm, *Spodoptera litura*; whitefly, *Bemisia tabaci*; Aphid, *Aphis craccivora*; Jassid, *Amrasca biguttula*; Thrips, *Frankliniella schultzei* were considered as the major pests, while the rests were of minor importance on the basis of population densities per plant, nature and extent of damage and yield reduction. Most of the major and minor pests appeared in the crop during vegetative to flowering stages (30-70 days after sowing) and the maximum insect population and their infestation occurred during vegetative and flowering stages of the crop.

Minor oilseeds

Variety development

Linseed

Maintenance and evaluation of linseed germplasm

Forty five linseed genotypes including check variety Neela were evaluated and maintained in the experimental field of Oilseed Research Centre, BARI, Gazipur during Rabi 2019-20. The highest % CV was recorded for the parameter 10 plant yield (g) followed by number of pod/plant and number of branches/plant. Collected seeds were conserved properly. The seed will be rejuvenates in the next year.

Observation trial of linseed

Eight linseed lines including released variety Neela were evaluated at ORC, BARI, Gazipur during Rabi 2019-20. Among the genotypes significant differences observed for days to flower, days to maturity, number of pods/plant and 10 plants yield (g). Maximum numbers of pods/plant were obtained from Lin-W-17 followed by Lin-1903.The maximum numbers of seeds per pod were found in Lin-2403 and Lin-1503/2. The highest yields per hectare were obtained from Lin-W-17 (1510 kg/ha) followed by Lin-1503/2 (1490 kg/ha) and Lin-2403 (1465 kg/ha) as compared to Neela.

Crop management

Screening of linseed genotypes against salinity at seedling stage

The experiment was conducted at the laboratory of Oilseed Research Centre, Bangladesh Agricultural Research Institute (BARI). Twenty four genotype of linseed were used. The experiment assessed the germination and seedling growth of linseed genotypes at control, 4, 8 and 12dS/m NaCl salinity levels. The salt solution was prepared by calculated amount of NaCl in Hogland solutions. The pH of solution was maintained at 6. Plastic pots were used in the experiment with a diameter of 10 cm, height was 9 cm and arranged in a completely randomized design (CRD) with four replications. Each pot was supplied with 500 ml of the respective treatment solution having cotton gauge which covered the lid with small holes through which the roots can reach the solution. Seeds were sown on the lid of the plastic pots. The germination count was taken after 72 hours of sowing of seeds. A seed was considered to have germinated when both the plumule and the radicle emerged > 0.5cm. After 15 days, the shoot and the root length of ten randomly selected seedlings from each replicate were measured following a draftsman ruler. Following ISTA (1999) rules seed quality such as percent of germination, root-shoot length and total dry weight was recorded.

Germination percentage (GP) $= \frac{a}{b} \times 100$ Where: a = Number of seeds germinated, b = Total numbers of seeds used

The plants were then collected from the pots and the following parameters were measured, i. Root Length (cm), ii. Shoot Length (cm) and iii. Total dry matter/plant (mg). All the seedling traits showed a decreasing trend irrespective of the genotypes to salinity stress. Lin-703 showed the maximum root length, shoot length and total dry matter under saline condition. Based on measured parameters it was found that Lin-2403, Lin 1507/2, Lin103, Lin 1703, Lin 1403, Lin 603, Lin 803 and Lin-703 performed good at high salt concentrations.

Performance of selected genotypes of linseed under rainfed condition

The experiment was laid out in field semi controlled condition at Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2019-20 to evaluate linseed genotypes under rainfed condition based on morphological and seed yield. Sixteen genotypes viz., BD 7142, Lin 603, Chapi, Lin 1203, Lin 103, JL-3, MEGR, BD 7146, BD 7146, Lin 1507/2, Lin 803, Lin 1308, JL-2, Tangail, BD 10703, Lin 303, Neela were considered for the study. The experiment was laid out in Randomized Complete Block Design with three replications. Seeds were sown on 04 December 2019. Fertilizers at the rate of $N_{36}P_{25}K_{25}$ kg/ha in the form of urea, TSP and MoP, respectively were applied. Full amount of triple super phosphate, muriate of potash (MOP) and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied 30 days after sowing. Soil moisture measured by soil moisture meter. Rainfed condition was maintained by restricting irrigation and plants were re-irrigated when they showed signs of wilting or leaf rolling. Slight rain have been recorded in the month of January. Besides, no rainfall occurred during crop production periods. After germination, plants were counted and excess plants were removed to maintain optimum plants/m^2 in each plot. The genotypes were harvested at maturity. Data were collected on days to flowering & maturity, total dry matter, yield contributing characters and yield. Collected data were analyzed statistically and means were adjusted by LSD test at 5% level of significance using SPSS.

The results indicated that soil moisture stress had significant effect on the seed yield of linseed genotypes. Water stress at all the growth stage reduced the yield. Drought susceptibility of a genotype is often measured as a function of the reduction in yield under drought stress (Blum, 1998). All genotypes gave good performance under non drought situation. Water stress during seed development reduced seed yield via reduction of seed weight. The highest seed yield (1105kg/ha) was obtained from Lin103 genotype and the lowest seed yield (800 kg/ha) from BD7146. It revealed from relative yield that 8-10% yield reduction in water stress condition compared to irrigated was in Lin 103 (8%), Lin 1203 (9%), Tangail (9%), Chapai (10%) and Lin 303(10%). Among the different genotypes, Lin103, Lin1203, Chapai, Lin303 and Tangail performed better under rainfed condition.

Niger

Variety development

Maintenance and evaluation of niger germplasm

A total of twenty one niger genotypes including Shova as check were grown to evaluate and maintain at ORC, BARI during rabi 2019-20. The highest % CV was observed for the parameter 10 plant yield followed by branches per plant. Collected seeds were stored properly to use for research work in the next year.

Safflower

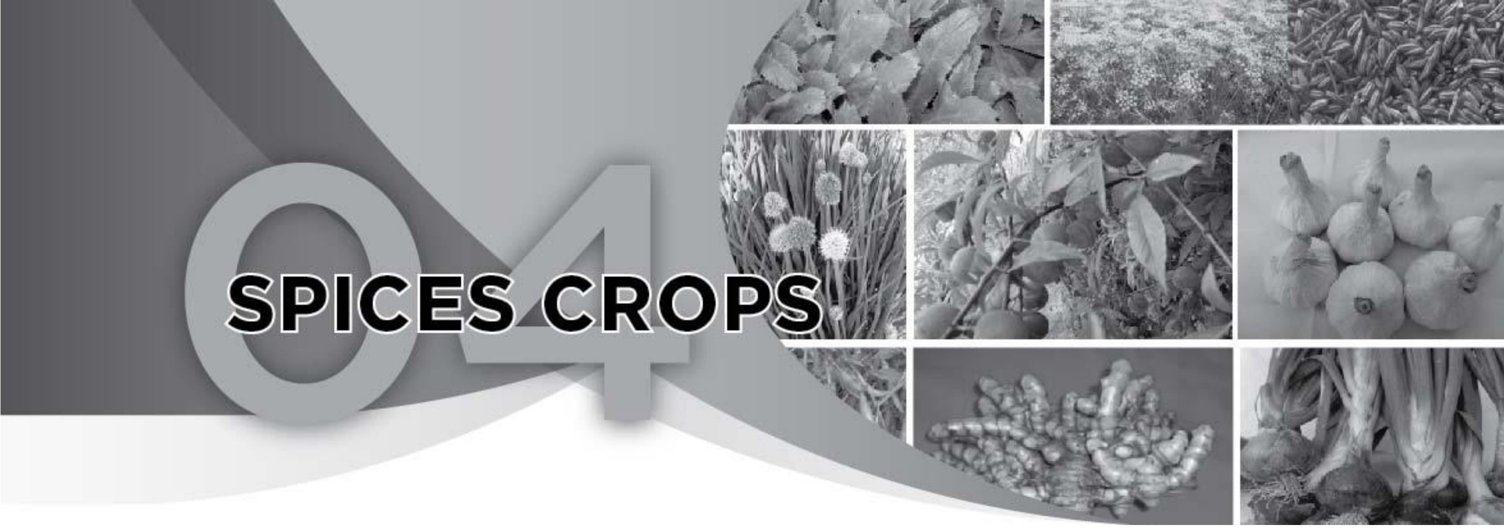
Variety development

Maintenance and evaluation of safflower germplasm

Seven Safflower genotypes including released variety BARI Saff-1 were grown to maintain and evaluation during Rabi 2019-20. The Maximum % CV were found for the parameter10 plant yield (g) followed by number of pod per plant. Collected seeds were preserved properly which would be grown next year for further research work.

Observation trial of safflower

A total of five Safflower lines including released variety BARI Saff-1 were evaluated at ORC, BARI, Gazipur during Rabi 2019-20. Among the genotypes the most dwarf genotypes were BARI SAFF-1 followed by SAF-T-17 and the tallest entry was SAF-504 as compared to check. The maximum yield (kg/ha) were obtained from BARI SAFF-1 (1002 kg/ha) followed by SAF-502 (860 kg/ha).



Onion

Varietal development

Collection, conservation and evaluation of onion germplasm

The present experiment was conducted to select superior winter onion germplasm for higher yield at Spices Research Centre, Shibganj, Bogra during 2019-2020. Twenty-three onion genotypes along with BARI Piaz-4 and Ac Gaz 379 as check were used in this study. The experiment was laid out in alpha lattice design with three replications. None of the germplasm out yielded the check entries. Considering yield and other attributing traits the genotype Ac Bog 413 was found promising.

Collection, conservation and evaluation of onion germplasm

The field experiment was conducted at Spices Research Sub-Centre (SRSC), Bangladesh Agricultural Research Institute (BARI), Faridpur, Bangladesh during 2019-2020. Twenty five onion germplasm with BARI Piaz-1 and BARI Piaz-4 (as check) were evaluated in a randomized complete block design in the trial. The study was focused on finding out promising onion line/s. The results revealed that onion lines/varieties studied differed significantly on yield attributes, yield and quality of onion. The genotype AC Bog 413 had superior performance in number of leaves per plant (8.85), neck size (1.32 cm), incidence of bolting (2.36%), disease severity (13.66%), diameter of bulb (4.98 cm), individual bulb weight (36.76 g), multiplier bulb (0.22%), days to maturity (103.33 days) and yield (25.37 t/ha) over the recommended varieties-BARI Piaz-1 and BARI Piaz-4. The AC Bog 413 gave heavier individual bulb (66.33 & 22.57%) and higher bulb yield (72.70 & 27.04%) than those of BARI Piaz-1 and BARI Piaz-4, respectively. The genotype AC Bog 413 showed lower split bulb (98.33 & 98.29%) and lower bolting (90.74 & 91.03%) than those of BARI Piaz-1 and BARI Piaz-4, respectively. The AC Bog 413 matched with the disease severity category 2 while BARI Piaz-1 and BARI Piaz-4 matched with the category 4 under 0-5 scale. However, the BARI Piaz-1 had higher dry matter content (17.32%), higher TSS content (18.00 °brix) and stronger pungency (5.00) than those of AC Bog 413 (15.53%, 14.50 °brix, & 4.00), respectively. The values of dry matter content, TSS content and pungency score for BARI Piaz-4 were 15.66%, 14.59 °brix and 4.00, respectively. Simultaneously BARI Piaz-1, AC Bog 413, AC Bog 426 and AC Bog 430 exhibited firmer bulbs (9.00) than that of BARI Piaz-4 (8.25). The skin and flesh colour of bulbs were identified as bronze red & white for BARI Piaz-1; red & white for BARI Piaz-4 and pink red & reddish for AC Bog 413. The variety BARI Piaz-4 and AC Bog 413 showed torpedo shape of bulb while BARI Piaz-1 showed flat shape of bulb. The AC Bog 413 showed the lowest storage loss (29.94%) among the genotypes/varieties followed by BARI Piaz-1 (35.53%), AC Bog 435 (36.09%), BARI Piaz-4 (37.38%) and AC Bog 430 (39.40%). The genotypes AC Bog 413, AC Bog 426 and AC Bog 430 were found to be promising lines compared to recommended onion varieties (BARI Piaz-1/BARI Piaz-4) in most characters measured.

Evaluation of collected onion germplasm for development of base population

An experiment was conducted to characterize, evaluate and utilize superior onion germplasm for bulb size, individual bulb weight (IBW), splitting (%), bolting (%), TSS (%),dry matter content (%), days to maturity and bulb yield (t/ha) at Regional

Spices Research Centre, BARI, Gazipur during 2019-2020. Thirty-one collected onion germplasm including two Check varieties BARI Onion-1 & 4 were characterized and evaluated in this experiment. The experiment was randomized in alpha lattice design with two replications. Ac Bog413 (22000 kg/ha), Ac Gaz383 (21666 kg/ha), Ac Bog417(19333 kg/ha), Ac Bog419(19333 kg/ha), Ac Bog 415 (18000 kg/ha), Ac Bog428 (17333.34 kgt/ha), Ac Bog381 (17000 kg/ha) and Ac Bog412 (16853 kg/ha) were found promising for Individual bulb weight, Bulbing Index, TSS(%), Dry matter content (%) and bulb yield.

Evaluation of polycross third generation onion population

The field experiment was carried on at Regional Spices Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the month from November 2019 to April 2020. Four selected polycrossed 3rd generation onion population were evaluated for bulb production. Variations among onion populations were observed in respect to plant and leaf production, bulb size and bulb yield. The population PC_3Gaz 001 gave the highest bulb yield (16.73 t/ha) while the lowest yield (14.35 t/ha) was obtained from PC_3Gaz 004. But uniformity in respect of color and shape was observed, still several shapes were found in each population. Bulbs from all genotypes need to sort on the basis of phenotypic parameters and further evaluation is required after seed production from the selected desired bulbs maintaining proper isolation with special care. Trial is to be continued.

Improvement of poly crossed onion population through mass selection

Four poly crossed onion bulb population was planted in separate line for random mating in a netting cage. Random mating was allowed among the population and seed from the individual lines were harvested and stored separately for utilization in next generation.

Development of diverse onion germplasm through hybridization

An experiment was conducted to produce F_1 bulbs from F_1 seeds with the main goal to develop diverse onion germplasm through hybridization at Spices Research Centre, Shibganj, Bogura during 2019-2020. BARI Piaz-1, BARI Piaz-4 and BARI Piaz-6 were used in this study. Diallel mating design was followed for crossing in the previous season 2018-2019. Approximately 7-11 Kg bulbs were harvested from the F_1 seeds.

Searching of male sterile and maintainer lines of onion

An experiment was conducted to search male sterile and maintainer lines of onion at Spices Research Centre, Shibganj, Bogura during 2019-2020. F_1 (AC Gaz 379) and BARI Piaz-4 bulbs were used in this study in the ongoing season with the aim of hybridizing between them. Due to synchronization problem, it was not possible to perform the hybridization; but approximately 50 g F_2 seeds from the F_1 (AC Gaz 379) bulbs and 60 g seeds from BARI Piaz-4 were harvested.

Purification of BARI released onion varieties

An experiment was conducted to purify existing onion varieties at Spices Research Centre, Shibganj, Bogura during 2019-2020. BARI Piaz-1 and BARI Piaz-4 were used in this study. Approximately 20 and 30 Kg bulbs of BARI Piaz-1 and BARI Piaz-4 varieties, respectively were selected and conserved as true to type. At the same time approximately 18 and 14 Kg bulbs of BARI Piaz-1 and BARI Piaz-4 varieties, respectively were discarded due to different size, shape and color.

Cultural management

Use of high speed rotary tiller (HSRT) and power tiller operated seeder (PTOS) for onion cultivation

A field study was carried out to judge the performance of power tiller operated seeder (PTOS) and to compare the yield, quality & economic of different planting methods of onion in the winter season of 2019-2020. The study lasted between November 2019 - April 2020 in winter season at Spices Research Sub-Centre (SRSC), Bangladesh Agricultural Research Institute (BARI), Faridpur, Bangladesh. The trial consisted of four treatments as: T_1) by high speed rotary tiller

(HSRT) + power tiller operated seeder (PTOS), T_2) by HSRT + transplanting of seedlings, T_3) by HSRT + direct seeding in the prepared main field with line and T_4) by HSRT + direct seeding in the prepared main field as broadcasting which was arranged in a randomized complete block design with three replications. The outcome of the study revealed that the treatments had a significant influence on the characteristics studied accept TSS content and yield of onion. Different economic traits of onion were varied among the planting methods. The bulbs of onion matured earlier (133.66 days) growing onion under the PTOS method as compared to the transplant (155.54 days). The maximum percent bolting (21.55%), dry matter content of bulb (18.45%), multiplier bulb (19.99%), diameter of bulb (3.58 cm) and individual bulb weight (24.01 g) were recorded under the transplanting method. All direct seeding methods showed insignificantly higher yield than that of transplanting one due to higher number of plants per square meter. The yield performance under the PTOS and transplanting method were 16.08 and 14.42 t/ha. In case of economic performance, the maximum gross margin (Tk. 194056), net return (Tk. 177056) and benefit-cost ratio (2.57) were calculated in the PTOS method to the transplants (Tk. 180944, Tk. 163944 and 2.07), respectively. The maximum economic benefits obtained from the PTOS due to less labour involving onion growing method. Henceforth, in addition to the seedling transplanting practice more adopted by farmers of Bangladesh, direct seeding by the PTOS as onion growing method may also be a good option for getting early crop and economic benefit in the areas where there will be seen scarcity of labour and higher labour cost in transplanting of seedlings.

Nutrient and water management

Effect of irrigation and nitrogen on yield and keeping quality of onion

This study investigated the effects of different Nitrogen (N) levels and irrigation regimes on yield and yield components of onion (*Allium cepa L.*) c.v. BARI Piaj-6 at Regional Spices Research Centre, Gazipur and Spices Research Sub-Centre, Lalamonirhat in 2019-2020. It was a factorial experiment laid out in Randomized Complete Block Design with three replications of two irrigation regimes and three N levels. Application of N at different levels and irrigation regime increased total and marketable bulb yield and their interaction showed a significant effect on vegetative and yield parameters and of water consumption of onion. Application of 100 kg Nha^{-1} and irrigation at 20% depletion of field capacity the highest bulb yield (12.2tha^{-1} and 10.23tha^{-1} in Gazipur and Lalmonirhat Location, respectively). Therefore, 100 kg Nha^{-1} and irrigation at 20% depletion of field capacity could be the tentatively recommended for onion cultivation in the studied area.

Effect of irrigation and nutrient management on seed yield of onion

This study investigated the effects of different irrigation regimes and nutrient management on seed yield and yield components of onion (*Allium cepa L.*) c.v. BARI Piaj-1 at Regional Spices Research Centre, Gazipur in 2019-2020. It was a factorial experiment laid out in Randomized Complete Block Design with three replications of two irrigation regimes and three nutrient management packages. Application of nutrient management and irrigation regime increased the seed yield and their interaction showed a significant effect on vegetative, reproductive and yield components and of water consumption of onion. Application of 75% RDCF + 6 t ha^{-1}of Cowdung and irrigation at 20% depletion of field capacity gave the highest seed yield (1267.3kgha-1). Therefore, 75% RDCF + 6 t ha^{-1}of Cowdung and irrigation at 20% depletion of field capacity could be the tentatively recommended for onion cultivation in the studied area.

Optimization of NPKS fertilizers for yield maximization of onion (*Allium cepa L.*)

The present study was initiated with the objective to identify the optimum rate of NPKS fertilizer for maximum bulb yield of onion (BARI Piaj-1) under AEZ-28. The study was conducted in Regional Spices Research Centre, BARI, Gazipur during the growing season of 2019-2020. Twelve NPKS fertilizer rates were laid down on Randomized Complete Block Design (RCBD) with three replications. The results of the experiment revealed that most of the growth and yield parameters of onion were significantly affected by NPKS fertilizer. Onion plants supplied with 100-60-40-30 kg NPKS ha^{-1} gave the marketable yield (10.9 ha^{-1}) and total bulb yield (11.4t ha^{-1}). Similarly, onion plants supplied with 100-60-80-0 kg NPKS ha^{-1} recorded the highest marginal rate of return (19.40%). Considering the yield, application of 100-60-40-30 kg NPKS ha^{-1} could be recommended for economical production of onion in the study area.

Insect pest and disease management

Identification of onion bulb associated fungi in storage and their management to reduce storage loss

The experiment was conducted at the field and store house of Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh during 2018-19 to identify post-harvest onion bulb associated fungi in storage and to find out the effective control measures to overcome the storage loss as well as to increase shelf-life of onion bulb. The field experiment was conducted for producing bulbs of BARI Piaz-1, BARI Piaz-2, BARI Piaz-3, BARI Piaz-4 and BARI Piaz-5 which were used in store house. Six treatments viz. Healthy and fresh Bulb, Bulb treatment with Cabriotop (0.3%), Bulb treatment with Provax 200 WP (0.25%), Bulb treatment with Amistar Top 325 SC (0.1%), Bulb treatment with Autostin DF (0.2%) and Control were used in store house. Aspergillus niger was the isolated storage fungi from onion bulbs. There were no effects of fungicides on rotten and sprouted bulbs of all varieties of onion during the whole storage periods. Summer varieties viz. BARI Piaz-2, BARI Piaz-3 and BARI Piaz-5 showed more than 50% rotten and sprouted bulbs at 32 DAI. But winter varieties viz. BARI Piaz-1 and BARI Piaz-4 showed more than 50% rotten and sprouted bulbs at 160 DAI. Among the winter varieties, BARI Piaz-4 was more stable to BARI Piaz-1.

Integrated management for fusarium basal rot of onion

The experiment was conducted at Regional Spices Research Centre, BARI, Magura during January 2019-20 to find out the integrated management for fusarium basal rot disease of onion. BARI piaz-5 was used as the test variety. The experiment was laid out in randomized complete block design with three replications and nine different treatments viz T_1:Autostin (carbendazim) @ .2%, T_2: Cabriotop (pyraclostrobin 5%+ metiram 55% WG) @ 0.3%, T_3: Differ 300 EC (Difenoconazole 15% + propiconazole 15%) @ .2%, T_4: Eminent pro (Tetraconazole 12.5% + Carbendazimn 15%) @ .1% T_5:Nativo75 (Tebuconazole 50% + Trifloxystrobin 25%) @ .05% T_6:Trichoderma mixed compost @ 50 kg/ha, T_7: Trichoderma suspension @ 5ml/l ,T_8 : Trichoderma powder @ 10kg/ha, T_9: control. Significant differences regarding yield and yield attributes were observed among different treatments. The highest yield (11.78 t/ha) was found from T_6 (Trichoderma mixed compost @ 50 kg/ha) which was significantly higher than those of other treatments. The lowest yield (7.85 t/ha) was found from control plot T_9. Significantly higher plant height (cm), number of leaves/plant, bulb diameter (cm), individual bulb weight, lowest disease incidence (6.60 %) were observed from treatment T_6 (Trichoderma mixed compost @ 50 kg/ha) and the highest disease incidence (25.78 %) was from in T_9 (control).

Post harvest technology

Studies on the processing and preservation of onion paste

This experiment was undertaken to study the paste behavior of treated and untreated onion of BARI piaz-4 under room temperature and refrigerated temperature. The fresh, peel and sliced onion were crushed in blender. The onion paste was prepared using 250 ml water per kg sliced onion. Among thirteen treatments, eleven samples of onion pastes were treated with salt, sodium benjoate, potassium metabisulphide, citric acid and mastered oil singly or in combination. Among other two, one sample was treated with steam and another was non treated onion paste. All the samples of prepared onion paste were stored in glass container and kept in room temperature. The colour, flavor, texture and overall acceptability of all the samples (treated and untreated) of onion paste were observed at 15 days interval up to 90 days storage.

Garlic

Varietal development

Advanced yield of garlic line

The study was conducted at the farm of Spices Research Centre, BARI, Shibgonj, Bogra during rabi season 2019-2020 to select the promising garlic germplasm for releasing a variety. The experiment was laid out in RCB design with three replications. Six different garlic lines (GC0038, GC0044, GC0035, GC0027, GC0031and GC0013) including BARI Rashus-3 as check were evaluated based on their yield and other desirable characters. Among the lines, the highest yield (12.580 t/ha) was obtained from GC0044 and the lowest (9.0 t/ha) was found from GC0031. Disease severity was also lower in GC0044. The significant 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 GC0035, GC0038, and GC0044 were found promising and selected for next year trial.

Evaluation of garlic germplasm

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra during rabi season 2019-2020 to select the promising garlic germplasm for releasing a variety. Sixteen different garlic lines (GC0043, GC0047, GC0046, GC0045, GC001, GC005, GC0012, GC0018, GC0029, GC0030, GC0017, GC0042, GC0036, GC0048, GC0049, GC0040) and BARI Rashun-3 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 (12.24 t/ha) was obtained from GC0049 and the lowest (6.74 t/ha) was found from GC0040. Disease severity was also lower in GC0049. Significantly all the yield contributing characters found better from GC0049.

Collection, conservation and evaluation of garlic germplasm

The study was conducted at the farm of Spices Research Sub-Centre, BARI, Faridpur during rabi season 2019-20 to select the promising garlic line(s) for releasing as a variety. The experiment was laid out in RCB design with three replication Five different garlic lines (AS Far 001, AS Far 002, AS Far 003, AS Far 004 and AS Far 005) including BARI Rashun – 4 as check variety. They were evaluated based on their yield and other desirable characters. Among the lines, highest yield (16.4 t/ha) was obtained from AS Far 005 and lowest was obtained (11.10 t/ha) from AS Far 001. Besides check variety BARI Rashun-4 showed yield 12.18 t/ha. plant height (78.42cm), bulb diameter (4.03cm), bulb length (2.78cm), No. of cloves per bulb (32.25), Individual bulb weight (24.09) were also obtained highest in AS Far 005 genotype. Clove length (2.26 cm), breadth (1.06 cm) and individual clove weight (0.81 g) were found highest in AS Far 004. Disease infestation was found low (40.03%) at AS Far oo3 and BARI Rashun-4 showed highest disease infestation (66.33%). Total soluble solid showed highest in AS Far 004 (38.17% ºbrix).

Nutrient and water management

Effect of nitrogen and variety on yield and yield components of garlic

A field experiment was carried out at Regional Spices Research Centre, Bangladesh Agricultural Research Institute, Gazipur during November 2019 to April 2020 to find out optimum dose of nitrogen and suitable garlic variety for higher yield. The experiment was laid out in factorial randomized complete design with three replications. BARI Rashun 1, 2, 3 and 4 were used as test materials in this trial. Four different levels of nitrogen viz. N_0, N_{50}, N_{100} and N_{150} kg ha^{-1} were applied in the experiment. The crop was raised with $P_{60}K_{160}S_{20}Zn_2B_1$kg ha^{-1} along with 5 t cowdung per hectare. Both the variety and nitrogen level significantly influence yield and yield components of garlic. Highest bulb yield of 7.40 t ha^{-1} was obtained from BARI Rashun -2 with 100 kg N ha^{-1}.

Post harvest technology

Studies on the processing and preservation of garlic paste

This experiment was undertaken to study the paste behavior of treated and untreated garlic paste under room temperature. The fresh, peel garlic cloves were crushed in blender. The garlic paste was prepared using 250 ml water per kg sliced onion.

Among fourteen treatments, twelve samples of garlic pastes was treated with salt, sodium benjoate, potassium metabisulphide, citric acid and mastered oil singly or in combination. Among other two, one sample was treated with steam and another was non treated garlic paste. All the samples of prepared garlic paste were stored in glass container and kept in room temperature. The colour, flavor, texture and overall acceptability of all the samples (treated and untreated) of garlic paste were observed at 15 days interval up to 180 days of storage. The colour, flavor and texture of the garlic pastes, treated with citric acid plus sodium benzoate or sodium chloride plus citric acid plus sodium benzoate or sodium chloride plus citric acid plus KMS and stored in glass container at room temperature were acceptable up to 180 days of storage. But garlic paste rendered more excellent shelf life up to 180 days of storage when treated with only citric acid. The study has shown that garlic paste without any preservative (control) could not be stored more than 75 days at room temperature.

Technology transfer

On farm verification trial of garlic variety

The experiment was conducted at Bhola Sadar during rabi season of 2019-20 with different types of BARI released garlic varieties to observe the performance of BARI released garlic varieties in farmers field. Five varieties viz: BARI Rashun-1, BARI Rashun-2, BARI Rashun-3, BARI Rashun-4 and Local Rashun were tested. Among the varieties BARI Rashun-4 gave highest yield (5.4 t/ha) followed by local Rashun (5.1 t/ha). BARI Rashun-2 gave the lowest seed yield (3.9 t/ha).

On farm verification trial of garlic variety

The experiment was conducted at MLT site Bauphal and MLT site Kuakata during rabi season of 2019-20 with different types of BARI released Garlic varieties, e.g: BARI Rashun-1, BARI Rashun -2, BARI Rashun -3, BARI Rashun -4 and Local Rashun to observe their performance in farmers' field. Among the varieties at both locations Bauphal and Kuakata BARI Rashun -3 gave the highest yield (5.06 t ha^{-1}) and (4.79 t ha^{-1}) respectively. Local Rashun gave the lowest seed yield (4.07 t ha^{-1} and 3.99 t ha^{-1}) at both locations.

Chilli

Varietal development

Regional yield trial of chilli

The present study was conducted on 6 Chilli genotypes across 4 environments in randomized complete block design with three replications during 2019-20 to evaluate the performance of chilli genotypes with higher yield and stability. The AMMI (Additive main effect and Multiplicative Interaction) model was used to estimate the genotype-environment interaction. Genotypes and environments were significantly varied for all the traits except plant height, fruit diameter and thousand seed weight against environment, which revealed the presence of genetic variability in the materials under study. The analysis of variance revealed that GEI accounted for 14.80 % of the total variation for yield while genotype explained 40.11 % and environments explained 45.09 % for the same. GGE biplot methodology was used for graphical display of yield data after subjecting the genotypic means of each environment to GGE biplot software. The first two principle components (PC1 and PC2) were used to display two-dimensional GGE biplot. Genotype Co631 and Co632 were found to be high yielding and stable in specific environments.

Regional yield trial of winter chilli

The study was conducted at Spices Research Centre Shibganj, Bogura; Regional Spices Research Centre, Gazipur, Magura and Cumilla during November 2019 to May 2020 with a view to observe the regional adaptability of the selected chilli lines at different chilli growing areas and to select promising winter chilli lines for releasing variety. Three advance lines of chilli (C0649, C0650 & C0701) with BARI Morich-3 as check were used in the study. The experiment was laid out in a randomized complete block design with four replications. Among the location, it was found that the highest number of fruits per plant and green chilli yield (309 and 13.27 t/ha, respectively) was found at Bogura location and the lowest number of fruits and green chilli yield (206 and 9.17 t/ha, respectively) was found at Gazipur location. Significantly the highest fruits weight per plant and green chilli yield (343.60 g and 13.32 t/ha, respectively) was recorded from C0701 followed by C0650 (287.08 g and 10.97 t/ha, respectively) and the lowest (237.84 g and 9.18 t/ha) was found from BARI Morich-3. In case of combined effect of location and chilli advanced lines, it was observed that C0701 gave the maximum fruits weight per plant and green chilli yield (402.33 g and 15.76t/ha, respectively) in Cumilla location. The lowest fruit weight per plant and green chilli yield (183.67 g and 7.33 t/ha, respectively) in was found from C0649 in Magura location. In respect of green chilli yield, the lines CO701 and C0650 performed better over the location.

Advanced yield trial of chilli

The present experiment was conducted to select superior chilli germplasm for higher yield at Spices Research Centre, Shibganj, Bogra during 2019-2020. Ten chilli genotypes including BARI Morich-2 and BARI Morich-3 as check were used in this study. The experiment was laid out in alpha lattice design with three replications. Quite a few genotypes out yielded the check entries. Considering yield and other attributing traits the genotype Mohona-2 found top yielder followed by F1HC, Indch 33 and Indch 41.

Advanced yield trial of winter chilli

The experiment was conducted at Spices Research Centre, Shibganj, Bogura during 2019-2020 with a view to develop suitable winter variety for green chilli. Two chilli lines viz., C0721 and C0722 along with BARI Morich-3 were used in this study. The experiment was laid out in a randomized complete block design with four replications. In case of days to 50% flowering, it was observed that C0721 produced 50% flowers within 59 days followed by C0722 (69 days) and the highest days were needed to 50% flowering (74 days) by BARI Morich-3. The minimum days were needed to produce 50% mature fruits (123 days) by C0721. The highest days were needed to produce 50% mature fruits (133 days) by BARI Morich-3. It was observed that C0721 gave the highest number of fruits per plant and the highest fruit weight per plant (343 and 408.12 g, respectively) and the lowest (249 and 264.20 g, respectively) were found from BARI Morich-3. The maximum fruit length (6.94 cm) was recorded from C0722 and the lowest fruit length (4.71 cm) was found from C0721. The line C0721 gave the highest green chilli yield (16.33t/ha) and BARI Morich-3 gave the lowest (10.61 t/ha).

Evaluation of winter chilli lines

The experiment was conducted at Spices Research Centre, Shibganj, Bogura during 2019-2020 with a view to identify suitable winter chilli line (s) and to develop good breeding line(s) for improvement of chilli. Three chilli lines viz., C0716, C0724, C0725 and BARI Morich-3 were used in this study. The experiment was laid out in a randomized complete block design with three replications. In case of days to 50% flowering, it was observed that C0724 produced 50% flowers within 61 days. The highest days was needed to 50% flowering (80 days) by C0725. The minimum days were needed to produce 50% mature fruits (112 days) by C0724 and the highest days were needed to produce 50% mature fruits (128 days) by BARI Morich-3. It was observed that C0724 given higher number of fruits and the highest fruit weight per plant (357 and 398.60 g, respectively) and the lowest of these parameters (199 and 210.10 g, respectively) were found from C0716. The highest single fruit weight (2.33 g) was found in C0724 followed by C0725 (2.06 g) and C0716 (1.98 g) and the lowest single fruit weight (1.83 g) was found from BARI Morich-3. The highest fruit length (8.26 cm) was recorded from C0724 and the lowest fruit length (6.26 cm) was found from C0716. The highest green chilli yield (13.13 t/ha) was found from C0724 and the lowest was recorded from C0716 (8.26 t/ha).

Collection, conservation and evaluation of chilli germplasm

The present experiment was conducted to select superior winter chilli germplasm for higher yield at Spices Research Centre, Shibganj, Bogra during 2019-2020. Twenty chilli genotypes including BARI Morich-3 as check were used in this study. The experiment was laid out in alpha lattice design with two replications. Quite a few genotypes out yielded the check entry BARI Morich-3. Considering yield and other attributing traits the genotype AVPP 1111 found top yielder followed by Indch 39 and A1511050.

Collection and evaluation of local germplasm of chilli in cumilla region

A total of eleven germplasm of chilli were collected from different upazilla of Cumilla district. The trial was conducted during rabi season of 2019-2020 at RSRC, BARI, Cumilla to study the performance of different chilli lines for developing variety having higher yield. The highest green chilli yield (10.53 t/ha) was in CA Cum-004 and the lowest (4.10t/ha) from the line CA Cum-011.

Regional yield trial of ornamental chilli

The experiment was conducted at Spices Research Center, Bogura, Regional Spices Research Center, Jaydebpur and Magura, Spices Research Sub Center, Faridpur and Spices Research Sub Center, Lalmonirhat during Rabi season of 2017-18, 2018-19 and 2019-20. Three promising ornamental chilli lines (OC 001, OC 002 and OC 010) were included in the study. The experiment was laid out in a RCB (factorial) with three replications. Significant differences among the chilli lines were observed in each location regarding different parameters. The highest amount of fruit (0.923 kg/plant in 2018-19 & 0.956 kg/plant in 2019-20) was harvested from the ornamental chilli line OC 002 in Bogura location because of its higher number of fruits per plant. The lowest amount of fruit (0.250 kg/plant in 2018-19 & 0.255 kg/plant in 2019-20) was harvested from OC 010 in Magura and Jaydebpur location respectively. Chile lines OC 002 and OC 001 shows better performance than OC 010 across the different locations due to their attractive fruit shape, colour, bushiness in nature and yield. So that, OC 002 and OC 001 these two lines has been proposed for releasing as ornamental chilli variety.

Characterization and evaluation of ornamental chilli germplasm

The research was carried out at the experimental field of Spices Research Centre, Shibganj, Bogura during rabi season, 2019-20 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. Nine ornamental chilli germplasm were characterized and evaluated for their performance. The characterization was done according to "Descriptors for capsicum" by IPGRI, AVRDC and CATIE (1995). The yield and yield contributing characters varied significantly among the different ornamental chilli germplasm. The highest amount of fruit (1.255 kg/plant) was harvested from the germplasm OC18 because of its biggest sized fruit and heaviest single fruit weight which was identical to OC 003 (1.122 kg/plant). The lower amount of fruit (0.217 kg /plant) was harvested from the germplasm OC 005 which was identical to OC 007 (0.243 kg/plant) followed by OC 006 (0.259 kg/plant) and OC 004 (0.345 kg/plant). Among the ornamental chilli germplasm OC 018 and OC 003 showed better performance in terms of yield potentiality. But the other germplasm also gave impressive results due to their different colored fruit and attractive canopy structure.

Evaluation of naga chilli lines

The experiment was conducted at CRS, Jaintapur, and Sylhet in rabi season from January to May 2020 for selecting superior line(s) as variety. Naga chilli lines were collected from different areas Sylhet and two naga chilli lines CC Jai-010 and CC Jai-018 were selected from preliminary trail for in depth study. The experiment was conducted in randomized complete block design (RCBD) with twelve replications. The experimental plot was located under AEZ 22 with sandy loam soil having extremely acidic (4.5-4.8) pH. All the growth parameters showed significant variation among the lines tested. Growth conditions of the lines were satisfactory. Maximum fruit size (5.2× 2.1cm) and weight (5.03 g) were obtained from CC Jai-010 while the minimum were from CC Jai-018. No mite's infestation was found in line CC Jai-010 hence may be considered as mite resistant. Considering all the parameters CC Jai-010 may be further investigated for advanced yield trial.

Cultural management

Effect of NAA on blossom drop in chilli

A two-years field experiment was carried out at Regional Spices Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the month from November 2018 to April 2019 and November 2019 to April 2020 to standardize the optimum doses and time of spraying of NAA as foliar spray in reducing blossom drop. The experiment included five different levels of NAA viz., 0 ppm (D_1), 10 ppm (D_2), 20 ppm (D_3), 30ppm (D_4) and 40 ppm (D_5) and three spraying time viz,25 DAP(S_1), 10 days after 1st flowering (S_2) and 25 days after 1st flowering (S_3). Seedlings of 35-40 days were transplanted on November 14, 2018 and November 20, 2019 maintaining a spacing of 50 cm× 50 cm in 3.0 m × 1.0m sized plot following RCB design (factorial) with three replications. Freshly prepared aqueous solution of NAA was sprayed three times according to treatments. The minimum flowers (83.33,54.58) and buds (51.56,8.5) were counted with the application of 10 ppm (D_2) followed by 20 ppm (D_3) in 2019-2020 and 2018-2019, respectively. Similarly, considering time of spraying NAA, minimum number of dropped buds (83.33, 9.25) and flowers (71.40, 66.5) were recorded at 10 days after 1st flowering. Application of 10 ppm NAA (D_2) and spraying at 10 days after 1st flowering (S_2) resulted minimum number of dropped flowers (71.3, 55) and buds (33,12.5) respectively followed by 20 ppm (D_3) NAA in two years trial. The maximum number of fruit (75.89, 65.35) and heavier fruits (210.5g,133.6 g) were harvested with the application of D_2 (10 ppm) followed by 56.78,62.15 and 137.44 g,128.8 g, respectively in D_3 (20 ppm) at 10 days after 1st flowering (S_2) in the trial of 2019-2020 and 2018-2019, respectively.

Effect of nitrogen and weather parameters on blossom drop in chilli

A field experiment was carried out at Regional Spices Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the month from November 2018 to April 2019 and November 2019 to April 2020 to find out optimum doses of nitrogen to reduce blossom drop and relation between nitrogen and weather parameters (temperature and relative humidity) on blossom drop in chilli. Four different levels of nitrogen, viz., N_1= 50, N_2 = 100, N_3= 150 and N_4 = 200 kg/ha were considered in the experiment. Seedlings of 35-40 days were transplanted on November 14, 2018 and November 19, 2019 maintaining a spacing of 50 cm × 50 cm in RCB design with three replications. In both years, the minimum number of dropped flowers (83.33, 314) and buds (25.33, 201.33) respectively were counted when 150 kg N/ha were applied. Similarly, the maximum number of dropped bud and flowers (>11 and >14) were counted in maximum plants where 200 kg/ha N was applied as influenced by daily temperature and humidity. The increase number of dropped bud and flowers were recorded with the increase doses of N (200 kg/ha) which might be positively linked with low temperature and high humidity. Application of nitrogen = N_3 (150 kg/ha) followed by N_2 (100 kg/ha) was found to be optimum to reduce blossom drop and positively linked with lower temperature and higher RH as well as produced maximum (116, 155.67) and heavier fruits (171.33g, 258.05g), respectively in both year.

Effect of lime on the growth and yield of Naga Chili

The experiment was conducted at Spices Research Sub-Station, Citrus Research Station, BARI, Jaintapur, Sylhet during the period from January 2020 to June 2020 to determine the effect of lime for Naga chilli production under acidic soil of north eastern region of Bangladesh. The experiment was laid out in randomized complete block design with three replications. Six different levels of lime were used as treatments viz.0, 0.5, 1.0, 1.5, 2.0 and 2.5 t/ha. There were significant variations among all the treatments. Among the treatments maximum plant height (100.00cm), maximum number of secondary branches (2.67), maximum fruit weight (5.36g) and maximum yield (24.26 t/ha) was recorded applying lime 2.5 t/ha. On the other hand, control (lime 0 t/ha) treatment yielded least value in all the parameters. Therefore, the results obtained from the study suggested that application of 2.5 t/ha lime has great effect on Naga chili increasing the yield attributes and can be recommended for farmers use in north eastern region of Bangladesh.

Nutrient and water management

Effect of different sources of nitrogen on the growth and yield of chilli

An experiment was conducted at the research field of Regional Spices Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2019- 2020 to evaluate the effect of different sources of nitrogen on growth and yield of chilli. The experiment was arranged in a RCBD with three replications having five treatments combinations. Different sources of nitrogen fertilizers had significant influenced on the plant height, days to anthesis, number of branches plant^{-1}, number of fruits plant^{-1}, fruit size, fruit yield plant^{-1}, single fruit weight, fresh fruit yield, number of seed fruit^{-1}, 1000 seed weight and seed yield except fruit size, dry fruit yield and germination days to fruit setting of chilli. The highest ripen fruit (8.50 tha^{-1}), dry fruit (3.03 t ha^{-1}) and seed (214.7 kg ha^{-1}) yield of chilli was obtained from $N_{100}K_{100}S_{30}Zn_3B_1$kg ha^{-1} (N from DAP) in the AEZ-28 (Madhupur Tract).

Insect pest and disease management

Management of Choanephora blight of chilli

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh during rabi season of 2019-20 to find out the effective control measures against Choanephora blight or wet rot disease of chilli. BARI Morich 3 was used in this experiment. Seven fungicides and one untreated control were used as treatment. Amistar Top 325 SC (0.1%) resulted the lowest disease incidence (7.88%) which was followed by Ridomil Gold (0.2%) and Autostin (0.15%), and untreated control showed the highest incidence (23.38%). The highest single fruit weight (3.60 g), fruit length (10.04 cm), number of fruits/plant (299.58) and weight of fruits/plant (697.29 g) were recorded in Amistar Top 325 SC (0.1%) sprayed plots which was followed by Ridomil Gold (0.2%) and Autostin (0.15%), and the lowest of these parameters were found in the untreated control plots. Amistar Top 325 SC (0.1%) sprayed plots showed the highest fresh yield (18.40 t/ha) which was also followed by Ridomil Gold (0.2%) and Autostin (0.15%), and untreated control showed the lowest yield (10.30 t/ha) of chilli.

Ginger

Varietal development

Regional yield trial of promising ginger lines

The experiment was conducted at Spices Research Centre, BARI, Shibgonj, Bogra and Spices Research Sub Center Lalmonirhat during April 2019 to March 2020 Four promising ginger lines (G005, G0028, G001and G0027) were included in the study with BARI Ginger-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 both the location regarding different parameters. Significantly the highest rhizome yield was found from G005 in Bogra (31.40 t/ha) and Lalmonirhat (30.24 t/ha) while the lowest rhizome yield was found from BARI Ginger-1 in both location (19.79 t/ha and 18.90 t/ha respectively). Significantly higher plant height, number of tillers/plant, number of leaves/plant, weight of primary and secondary rhizome, dry matter (%) and yield along with better yield contributing characters were observed from the line G005. The highest dry matter (%) of 27.80 and 27.20 was found from G005 in Bogra and Lalmonirhat locations, respectively. The lowest dry matter 18.81 % and 19.00 % was obtained from BARI Ada-1 at Bogra and Lalmonirhat locations, respectively.

Evaluation of ginger germplasm

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogra during April 2019 to February 2020 to select the promising ginger germplasm for releasing a variety. Twenty different ginger lines (G0020, G0021, G0022, G0023, G0033, G0044, G0025, G0026, G0034, G0041, G0042, G0046, G0045, G0043, G004, G0010, G0036, 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 were observed in the line G0044. The highest yield (35.20 t/ha) was also obtained from G0044 and the lowest yield (18.51 t/ha) was found from G0021 line.

Evaluation of exotic ginger germplasm

The experiment was conducted at Regional Spices Research Centre, Gazipur during April, 2019 to February, 2020. Eleven ginger germplasm collected from different countries were considered in the trial. The rhizome of each entry was planted on 22

April 2019 in two rows plot of 4.0m x 1.0m. The inter row and intra row spacing were 50cm and 25 cm respectively. The crop was harvested on 23 February, 2020. The rhizomes were evaluated by characterization in this year. Among 17, only nine characters were evaluated viz., plant growth habit, plant height (cm), number of shoots/ tillers, height of shoot/ tiller, shoot diameter, number of leaves, rhizome thickness, rhizome shape, clump weight (g). Different plant and rhizome characters of ginger varied in different germplasm. Among the germplasm, GO GAZ 005 possessed of heavier clump (520.0 g) followed by GO GAZ 001, GO GAZ 003, GO GAZ 007 and GO GAZ 008.

Insect pest and disease management

Adaptive trial of technology for management of rhizome rot of ginger

The adaptive trial was conducted in farmer's field of Vobaniganj, Mohasthan, Bogura during 2019-20 to validate the technology for management of rhizome rot disease of ginger. Two treatments were used in this study. The test ginger variety was BARI Ada-1. T_1 (Selection of healthy seed (bacteria free) + seed treatment with Bordeaux mixture 1 day before sowing + application of SBP (20 kg/ha) + application of Dolochun 4 kg/decimal + application of Boric acid (7.5 kg/ha) + spraying of Bordeaux mixture 3 times at 20 days interval at 60 days after germination) resulted the lowest Rhizome rot incidence (9.69%) and T_2 (Farmer's practice) resulted the highest incidence (20.83%). T_1 showed the plant survival with 93.31% and disease reduction over control with 53.48%. The highest germination (95.55%), number and weight of primary and secondary rhizomes, and yield (29.47 t/ha) were found in T_1, and the lowest of these parameters were recorded in T_2.

Integrated management of rhizome rot disease of ginger

The experiment was conducted in infected sick plot with rhizome rot disease at Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh during 2019-20 to find the effective control measures of rhizome rot through an integrated management. Eight integrated treatments including control were used in this experiment. The test variety was used BARI Ada 2. The highest germination (95.45%) was recorded in Rhizome treatment with Ridomil gold (0.25%) + Soil drenching with Bordeaux mixture, first drenching was done during planting, thereafter, drenching was continued at 20 days interval starting from 40 DAP and the lowest germinaition (88.33%) was recorded from untreated control. Rhizome treatment with Ridomil gold (0.25%) + Soil drenching with Bordeaux mixture, first drenching was done during planting, thereafter, drenching was continued at 20 days interval starting from 40 DAP resulted the lowest Rhizome rot incidence (14.45%) and control treatment showed the highest Rhizome rot incidence (46.95%). Rhizome treatment with Ridomil gold (0.25%) + Soil drenching with Bordeaux mixture, first drenching was done during planting, thereafter, drenching was continued at 20 days interval starting from 40 DAP showed the highest yield (26.95 t/ha) and control treatment showed the lowest yield (10.66 t/ha).

Post harvest technology

Study on dehydrated ginger powder and its post dehydration physico-chemical studies (with peeling and without peeling)

This research was undertaken to develop processing techniques of peeled and unpeeled ginger to reduce post-harvest losses and preserve ginger using low cost conventional technology based on dehydration process. The peeled and unpeeled ginger of two SRC released varieties named BARI Ada-1 and BARI Ada-2 were used in this experiment. The dehydration was carried out by pretreatment, osmotic dehydration and /or combined pretreatment /osmotic dehydration and air drying in a cabinet dryer. Drying of ginger was done in a cabinet dryer at low temperature (60ºC) for specific moisture. Thus shelf stable products could be developed by mechanical drying with or without pretreatments. The dehydrated ginger powder was packed in aluminium foil and stored in room and refrigerated temperature. The chemical compositions of the fresh and dehydrated ginger products were determined and it was observed that the qualities of the products were satisfactory. Organoleptic taste testing using 1-9 hedonic scale showed that all the developed products were accepted by the panelists. The study thus shows that high quality shelf-stable ginger products can be developed utilizing available low cost dehydration processes and thereby, post-harvest losses of peeled and unpeeled ginger can be reduced to an acceptable level.

Studies on quality of developed ginger-garlic mix paste during storage

This experiment was undertaken to study the paste behavior of treated and untreated ginger-garlic mix paste under room temperature and refrigerated temperarature. The fresh, peel ginger sliced and garlic cloves were crushed in blender. The mix paste was prepared using 250 ml water per kg of ginger sliced and garlic cloves. Among fourteen treatments, twelve samples of mix pastes was treated with salt, sodium benjoate, potassium metabisulphide, citric acid and mastered oil singly or in combination. Among other two, one sample was treated with steam and another was non treated ginger-garlic paste. All the samples of prepared mix paste were stored in glass container and kept in room temperature and refrigerated temperature. The colour, flavor, texture and overall acceptability of all the samples (treated and untreated) were observed at 15 days interval up to 90 days storage.

Turmeric

Varietal development

Advanced yield trial of turmeric

The present experiment was conducted to select superior turmeric lines for higher yield at Spices Research Centre, Shibganj, Bogra during 2019-2020. Eight turmeric genotypes including BARI Holud-4 and BARI Holud-5 as check were used in this study. The experiment was laid out in alpha lattice design with three replications. No genotypes were out yielded the check entries. The trial needed to be continued including a new set of promising genotypes in next season.

Evaluation of turmeric germplasm

The present experiment was conducted to select superior turmeric lines for higher yield at Spices Research Centre, Shibganj, Bogra during 2019-2020. Seventy-two turmeric genotypes including five BARI released turmeric varieties as checks were used in this study. The experiment was laid out in alpha lattice design with two replications. Nine genotypes were out yielded the best check entry BARI Holud-4. The promising genotypes needed to be evaluated in a large plot under advanced yield trial in next season.

Characterization and evaluation of turmeric lines

The experiment was conducted at Hill Agricultural Research Station, Khagrachari during May, 2019 to February, 2020. Four turmeric lines were considered for evaluation in RCB design with three replications. The highest leaf length (48.26 cm) was found in CL Kha 006 followed by CL Kha 002 (43.98 cm) which was statisticaly similar to CL Kha 003 (42.92 cm). The highest number of primary fingers / clump (13) and secondary fingers / clump (22.00) was obtained from CL Kha 002 which was statisticaly similar to CL Kha 006. Weight of primary fingers (221.00 g) and mother rhizomes per clump (93.16 g) were highest in CL kha002 and that were statisticaly similar to CL Kha 006. CL Kha 002 possessed the highest finger breadth (2.73 cm) which was statisticaly similar to CL Kha 009 (2.43 cm) followed by CL Kha 003 and CL Kha 006. Weight of secondary finger/ clump (116.73 g) and rhizome yield /clump was highest (430.83 g) in CL Kha 002 followed.

Coriander

Varietal development

Evaluation of coriander germplasm

An experiment was conducted to select superior coriander germplasm for higher yield at Spices Research Centre, BARI, Shibganj, Bogura during rabi 2019-2020. Twenty five different coriander genotypes were evaluated based on their yield attributes and yield. The experiment was laid out in RCB design with three replications. All traits are significant considering among the genotypes. Considering yield and other attributing traits the genotype COR 24 and COR 31 were found promising.

Technology transfer

Performance of BARI Dhania-1 and BARI Kalozira-1 at char land

The performance trial was conducted at char Rajibpur, Lalmonirhat sadar under Lalmonirhat district during November 2019 to April 2020. Two minor spices BARI Dhania-1 and BARI Kalozira-1 were included in the study. Spices seed with required chemical fertilizers had supplied to one farmer for cultivation of 30 decimal land. The results revealed that excellent crop condition occurred during growing season. The average yield of BARI Dhania-1 aqnd BARI Kalozira-1 were 7.48 and 4.33 kg/decimal, respectively.

Black cumin

Varietal development

Advance yield trial of black cumin

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogura during rabi season 2019-2020 to evaluate four advance black cumin germplasm and to identify the superior one(s) for regional yield trail. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a RCB design with three replications. Four advance black cumin germplasm (viz. BC 010, BC 011, BC 012 and BC 014) were evaluated against BARI Kalozira-1 as check. Seed yield and other yield contributing characters were significantly different except capsule length and capsule diameter. The higher amount of seed 1.141 t/ha was harvested from the germplasm BC 014 followed by BC 011 (1.017 t/ha). The lower amount of seed 0.849 t/ha was harvested from the germplasm BC 010 followed by BARI Kalozira-1 (0.853 t/ha). BC 014, BC 011 and BC 012 performed better than BARI Kalozira-1 and selected for RYT in the next year.

Evaluation of black cumin germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogura during rabi season 2019-2020 to evaluate different black cumin germplasm collected from different sources and to identify the best germplasm with higher yield and other desirable characters. The land was medium high and the soil was clay loam in texture. The experiment was laid out in a RCB Design with three replications. Eigjteen different black cumin germplasm (viz. BC 013, BC 015-1, BC 015-2, BC 016, BC 018, BC 019-1, BC 019-2, BC 019-3, BC 019-4, BC 019-5, BC 019-6, BC 020-2, BC 022, BC 024, BC 025, BC 026, BC 028 and BC 029) were evaluated against BARI Kalozira-1 as check. Seed yield and other yield contributing characters were significantly different except capsule length and capsule diameter The higher amount of seed 1.070 t/ha was harvested from the germplasm BC 028 followed by BC 016 (0.982 t/ha). The lower amount of seed 0.276 t/ha was harvested from the germplasm BC 029 followed by BC 018 (0.377 t/ha). This is the first year experiment the trial will be repeated in the next year for confirmation of the results.

Screening of black cumin germplasm for salinity tolerance

The experiment was conducted at Regional Spices Research Centre, BARI, Magura during November 2019-2020 to find out salinity tolerance of some black cumin germplasm. There were nine black cumin line viz. BC 01, BC 03, BC 04, BC 05, BC 06, BC 07, BC 08, BC 09, BC 14 along with BARI Kalozira-1. The experiment was laid out in completely randomized design with three replications and five different treatments viz T_1: control (tap water), T_2: 4 dS/m, T_3: 6 dS/m, T_4: 8 dS/m, T_5: 10 dS/m. Significant differences regarding yield and yield attributes were observed among different treatments. All the recorded attributes like germination %, number of branches, number of capsule, number of seeds per capsule and yield were significantly decreased by increasing level of salinity compared with control. Higher levels of salinity as in T4 (8 dS/m) and T5 (10 dS/m) proved more hazardous for black cumin plant. In conclusion, growth and yield of black cumin decreases with increasing levels of salinity.

Cultural management

Effects of thinning and irrigation regimes on the growth quality and yield of black cumin

In this study, the effects of different thinning level under different irrigation regimes on the growth, yield and quality of black cumin were observed in a field experiment. This experiment was laid out in RCB Design (two-factor) with three replications during 2019-2020 at the Spices Research Sub-Cetre, BARI, Lalmonirhat. Four thinning level (T_1=1st thinning 25 days after sowing), (T_2=2nd thinning 35 days after sowing), (T_3=3rd thinning 45 days after sowing), T_4=control(no thinning) and three irrigation regimes (I_1= vegetative stage + flowering stage), (I_2= Vegetative stage + casules stage), (I_3= Vegetative stage + flowering stage + capsules stage) were used as treatment. Results showed that growth, yield component, yield and quality of black cumin were affected by different thinning level except plant height (cm) while non-significant effects showed over yield component, plant population and quality (thousand grain weight and germination percentage) by different irrigation regimes. The combination of second thinning and irrigation regimes (vegetative stage + flowering stage) produced the highest number of branching/plant (5.96), number of capsules/plant (22.38), number of seeds/capsules (75.30), thousand seed weight (3.00g), germination percentage (92.28%). The maximum yield was recorded from treatment combination of no thinning and all irrigation regimes which was statistically similar to treatment combination of second thinning and irrigation regimes (vegetative stage + flowering stage).

Nutrient and water management

Determination of p, k and s for yield maximization of black cumin

A field experiment was conducted to study the response of P, K and S for yield and quality of black cumin cv. BARI Kalozira-1, conducted during 2019-2020 at Experimental field of Regional Spices Research Centre, BARI, Gazipur. It comprised of 10 fertilizers treatment of black cumin in randomized compile block design with three replications. The growth and yield parameters of black cumin were significantly affected by the different fertilizer packages. The maximum seed yield (996.7 $kgha^{-1}$) and the maximum harvest index (68.26%) was obtained in 40-60-20 kg PKS ha^{-1}. The black cumin fertilized by 40-60-20 kg PKS ha^{-1} might be the recommended nutrient package for satisfactory seed yield in the study area.

Fengreek

Varietal development

Evaluation of fenugreek germplasm

The trial was conducted at Spices Research Centre, BARI Shibganj, Bogura during rabi season of 2019-2020 to evaluate the fenugreek germplasm collected from different sources in terms of their seed size & yield potential and to identify the best one(s). The experiment was laid out in a RCB design with three replications. Thirteen different fenugreek germplasm (FK 025, FK 027, FK 028, FK 029, FK 030, FK 031, FK 032-1, FK 032-2, FK 034, FK 035, FK 036, FK 037 and FK 039) were evaluated against recommended variety BARI Methi-3. Seed yield and other yield contributing characters were significantly varied among the germplasm. The germplasm FK 029, FK 030, FK 027, FK 028, FK 031 and FK 037 produces higher seed yield and heavier seeds than the BARI Methi-3. So that, these germplasm will be taken for Advance Yield Trial (AYT) in the next year.

Sickle fruit fenugreek

Varietal development

Evaluation of sickle fruit fenugreek germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogura during rabi season of 2019-2020 to identify the best genotype with higher yield and desirable characters. The experiment was laid out in RCB design with three replications. Five different sickle fruit fenugreek (Firingi) germplasms were evaluated for yield and yield contributing characters. Seed yield and other yield contributing characters were significantly different except pods/ plant among the studied genotypes. The highest plant height was recorded from FRG 03 (63.80 cm). The lowest plant height was found in FRG 02 (54.93 cm). The highest pod yield (2.15 t/ha) were recorded from FRG 02. In case of seed yield, FRG 02 performed best (0.64 t/ha).

Fennel

Varietal development

Evaluation of fennel germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogura during rabi season of 2019-2020 to identify the best genotypes with higher yield and desirable characters. The experiment was laid out in RCB design with three replications. Eleven different fennel genotypes with newly released variety were evaluated for yield and yield contributing characters. Seed yield and other yield contributing characters were significantly different among the genotypes. The highest plant height was recorded from FN 17 (156.80 cm). The higher seed yield was obtained from FN 2 (1.15 t/ha). The lowest seed yield was recorded from FN 12 (0.50 t/ha).

Dill

Varietal development

Evaluation of dill germplasm

The trial was conducted at Spices Research Centre, BARI, Shibganj, Bogura during rabi season of 2019-2020 to identify the best genotypes with higher yield and desirable characters. The experiment was laid out in RCB design with three replications. Nine different dill genotypes with BARI Soluk 1 as check were evaluated for yield and yield contributing characters. Seed yield and other yield contributing characters were significantly different except number of umbel lates/umbel and 1000- seed weight among the genotypes. The highest plant height was recorded from DL 09 (113.60 cm). The lowest plant height was found in BARI Soluk 1(91.33 cm). The highest number of umbels/plant (54.40) was observed in DL 02 and the lowest was recorded from DL 04 and DL 05(34.47). In case of seed yield, DL 02 performed best (1.63 t/ha).

Insect pest and disease management

Management of alternaria leaf and umbel blight of dill

The experiment was conducted at Spices Research Centre, BARI, Shibganj, Bogura, Bangladesh during Rabi season of 2019-20 to find out the effective fungicides in controlling Alternaria leaf and umbel blight of Dill. BARI Sholuk-1 was used in this experiment. Seven fungicides and one control were used as treatments. Alternaria leaf and umbel blight incidence of Dill under different treatments varied from 7.58 - 85.11%, while the lowest incidence was recorded in seed treatment and foliar spraying with Amistar Top 325 SC (0.1%) and the highest incidence was obtained from control plot. Seed treatment and foliar spraying with Amistar Top 325 SC (0.1%) gave the highest number of umbels per plant (88.96), number of umbel lets per umbel (61.20), number of umbel lets per plant (6118), number of seeds per umbel (105.78), weight of seeds per umbel (0.50 g), number of seeds per plant (2311), weight of seeds per plant (21.50 g) and seed yield (2.20 t/ha) which was followed by seed treatment and foliar spraying with Rovral 50 WP (0.2%) and seed treatment and foliar spraying with Secure 600 WG (0.15%), and the lowest of these parameters were recorded in untreated control plots.

Celery

Varietal development

Regional yield trial of celery

The trial was conducted during rabi season of 2018-19 and 2019-20 to evaluate the performance of advance celery germplasm at different agro ecological zone and to select the promising one for releasing a variety. The experiment was laid out in a RCB Design with three replications. Two advanced fenugreek germplasm CL001 and CL005 were evaluated against local celery germplasm. The trial was conducted at five different locations viz,. SRC, Bogura, RSRC, Magura, RSRC, Cumilla, SRSC, Faridpur and SRSC, Lalmonirhat. Seed yield and other yield contributing characters were statistically significant among the germplasm in different location. The highest seed yield (1.87 t/ha in 2018-19 & 1.77 t/ha 2019-20) was recorded from the celery line CL 001 in SRC, Bogura location and the lowest seed yield (0.75 t/ha in 2018-19 & 0.45 t/ha 2019-20) was recorded from the local celery germplasm in Faridpur and Magura location respectively. It was found that the advanced celery line CL 001 performed better in all location over the years. So that, the line CL 001 will be applied for registration and release as a new celery variety as BARI Radhuni-1.

Ajowan

Varietal development

Regional yield trial of two ajowan lines

The experiment was conducted at the Regional Spices Research Center, BARI, Gazipur during November, 2019 to March 2020 to assess performance of two previously selected Ajowan lines and to select the best one in respect of yield and agronomic traits. Selected lines viz. TA GAZ 001 and TA GAZ 002 were evaluated in the field using a RCB design with 6 replications. There was no significant difference in respect to most of the yield and yield attributing parameters. All the lines took similar duration for flowering and harvesting. Statistically similar plant height, number of umbels/plant, umbellule/umbel seeds/umbellule, seeds/umbel and seeds/plant were recorded. The line TC GAZ 002 gave the maximum seed yield per plant (22.09g) but the local gave the highest seed yield (784.82 kg/ha).

Cultural management

Effect of seed rate on growth and yield of ajowan

A field experiment was conducted at Spices Research Sub-Centre, Faridpur during rabi season, 2019-20 to find out the optimum seed rate for growth and yield of ajowan. The trial was set at high land of Low Ganges River Floodplain (AEZ 12). The experiment was laid out in a RCB Design with three replications and comprised of different five seed rate viz. 3.0, 3.5, 4.0,4.5 and 5.0 kg/ha. Seeds were sown in line. The results revealed that different treatments had significant effect on yield and others parameters. The highest seed yield (1051.44 kg/ha) was recorded from the treatment of 4.5 kg seed/ha followed by the seed rate 4.0 kg/ha (1020.62kg). The lowest seed yield (925.46 kg/ha) was observed at 3.00 kg seed/ha.

Isabgul

Varietal development

Collection, conservation, cataloguing and evaluation of isabgul (*Plantago ovata*) germplasm

The experiment was conducted at the research field of Regional Spices Research Centre, Magura during rabi season, 2019-20 to evaluate the performance of different Isabgul (Plantago ovata) germplasm and to select the promising one(s) for releasing a variety. Four germplasm was collected from different part of Bangladesh. The experiment was laid out in randomized complete block design with three replications. The highest plant height (42.33cm), number of tillers per plant (7.33), number of leaves per plant (74), Length of leaf (30.00 cm), number of spikes per plant (29.0), length of spike (4.03cm), 1000 seeds weight (2.0g) and seed yield (823kg/ha) was found from the Isabgul line PO-001 and the lowest Plant height (39.67cm), number of tillers per plant (6.33), number of leaves per plant (69.33), length of leaf (26.33 cm), number of spikes per plant (23.0), length of spike (3.67cm), 1000 seeds weight (1.87g) and seed yield (705kg/ha) was found from the Isabgul line PO-004.

Bay leaf

Varietal development

Evaluation of bay leaf germplasm

The study was conducted at spices research sub-station, BARI, Jaintiapur, Sylhet from 2014 to 2019. Three bay leaf germplasm were initially selected for the study. But after releasing of BARI Tejpata-1, it was added to the study as a check. A wide variability was observed in different parameters such as pungency and leaf size, leaf thickness, yield, pest and diseases infestation among the germplasm studied. CT Jai-001 was superior with biggest leaf followed by BARI Tejpata-1. Among the accessions CT Jai-001 also gave highest yield followed by CT Jai-003. Moreover, CT Jai-003 was superior having the maximum leaf pungency and aroma. Therefore, CT Jai-003 could be selected as a variety for farmers' cultivation.

Nutrient and water management

Effect of nutrient management on growth and leaf yield of bay leaf

A field experiment was conducted to study the response of different nutrient management package for yield and quality of Bay leaf, conducted during 2019-2020 at Experimental bay leaf garden of Regional Spices Research Centre, BARI, Gazipur. It comprised on 05 nutrient management treatment of bay leaf in recommended block design with two replications. The growth parameters of bay leaf were significantly affected by the different management packages. The maximum increase in plant height (15cm), the plant height (3.90cm), annual shoot growth (15.16cm) and leaf area (19.23 cm^2) was observed in the treatment T4: 165-70-150-40-5-3g NPKSZnB + 4 kg mustard oil cake $tree^{-1}year^{-1}$. The maximum number of leaves per feet of shoot (18.17), leaf dry weight (1.47g), leaf yield (7.70 $kgtree^{-1}$) were found significantly higher by the application of 165-70-150-40-5-3g NPKSZnB + 4 kg mustard oil cake $tree^{-1}year^{-1}$ is recommended for bay leaf cultivation in the study area.

Plum

Nutrient and water management

Effect of nutrient management on fruit yield and quality of plum

A field experiment was conducted to study the response of different nutrient management package for yield and quality of plum cv. BARI Alubukhara-1, conducted during 2019-2020 at Experimental plum orchard of Regional Spices Research Centre, BARI, Gazipur. It comprised on 05 nutrient management treatment of plum in recommended block design with two replications. The growth parameters of plum were significantly affected by the different management packages. The maximum increase in plant height (23cm), the plant height (3.63m), annual shoot growth (13.80cm) and leaf area (12.80 cm^2) was observed in the treatment T4: 250-100-150-40-5-4g NPKSZnB + 3kg mustard oil cake $tree^{-1}year^{-1}$. The maximum number of fruit set per feet of shoot (16.93), single fruit weight (10.93g), fruit yield (12.93 $kgtree^{-1}$) were found significantly higher by the application of 250-100-150-40-5-4g NPKSZnB + 3kg mustard oil cake $tree^{-1}year^{-1}$is recommended for plum cultivation in the study area.

Post-harvest technology

Development of shelf stable value added products from plum (*Prunus domestica*)

The present study was concerned with the different ingredients of developed plum pickles depending on the processing techniques used. The acceptability of processed pickles were organoleptically evaluated by the panelists using 1-9 hedonic scale. The panelists were selected at random from different class of people. The panelists tasted the products and assigned marks for colour, flavor, texture, pungency, taste and overall acceptability. The mean score for colour, flavor, texture, pungency, taste and overall acceptability showed that all samples secured score within the acceptable limit ranging from 6.6 to 8.1, ranking ‘like slightly to ‘like very much’. The test score indicated that among three samples, the pickle which was processed with puncturing was most acceptable. Storage studies were carried out for up to twelve months at room temperature (25-30^0C) at an interval of one month up to first 4months and at an interval of 2 month for the consecutive 8 months. Organoleptic taste testing showed that all the developed products were accepted by the panelists. The study thus shows that high quality shelf-stable plum pickle can be developed utilizing available low cost processing processes and thereby, post-harvest losses of plum can be reduced to an acceptable level.

Formulation of different processed products from plum

This main objective of plum processing is minimize post-harvest loss and to supply wholesome, safe, nutritious and acceptable processed food to consumers throughout the year. Hence a study was conducted to develop processed plum products namely murobba, bar, candy and jam to evaluate, their sensory characteristics like the appearance/colour, flavor, taste, pungency, texture and overall acceptability. The study also showed that murobba can stored in room and refrigerated temperature more than one years. On the other hand bar, candy and jam can stored in room temperature only for three month but in refrigerated temperature it can be stored for more than one years. The results also noticed that all the plum processed products were acceptable equally to consumers. In statistical analysis it was already shown that all the samples were statistically identical.

Black pepper

Cultural management

Effect of different living and non-living standards on the establishment, growth and yield of black pepper cv. BARI Golmorich-1

An experiment was conducted to study different living and non-living standards on the establishment, growth and yield of black pepper cv. BARI Golmorich-1 at Spices Research Sub-station, BARI, Jaintapur, Sylhet from September' 2018 to May' 2019. The experiment consists of three different living and non-living standards as treatment viz. T_1= Reinforced concrete posts, T_2=Bhadi tree (*Lanneagrandis* D.) and T_3=Mandar tree **(***Erythrina* indica). The experiment was conducted in RCB Design with four replications. The vines in Bhadi tree exhibited superior performance with respect to average height of vine (215.67 cm) and average number of branches/vine (14).

Effect of different standard on growth and yield of black pepper (*P. nigrum*)

The experiment was conducted at Hill Agricultural Research Station, Khagrachari during May, 2019 to February, 2024.jantia Golmorich was considered for evaluation in RCB design with three replications. The highest plant hight was found in Sesbania grandifolia (7 fit). Similerly the highest Leaf width was found 6.33cm in Sesbania grandifolia. The highest internode length was found in Iron shandard surrounding by half inch iron mesh.

Effect of different potting media on the success and survivability of black pepper cutting in nursery

The experiment was conducted at Spices Research Sub-station, Citrus research station, Bangladesh Agricultural Research Institute, Jaintiapur, Sylhet during the period from May 2020 to July 2020 to select suitable potting media for quality planting materials production. There were nine treatments. viz. T1 = Soil , T2 = Cocodust, T3 = Soil + Cocodust (1:1), T4 = Soil + Vermicompost soil (1:1), T5 = Soil + FYM (1:1), T6 = Cocodust + Vermicompost (1:1), T7 = Cocodust + FYM (1:1) , T8 = Soil + Cocodust + Vermicompost (1:1:1), T9 = Soil + Cocodust + FYM (1:1:1) with three replications. The study revealed that, among the different growth media Cocodust + Vermicompost (1:1) helped in early sprouting (17 days) and highest success (100%). However, the cuttings raised on Cocodust + Vermicompost (1:1) significantly increased the different root and shoot parameters of cuttings such as, survivality (94.33%), number of leaves per cutting (4.67), number of primary roots cutting (15.67), length of root (24 cm), length of shoot (37 cm), fresh weight of root (1.05 g), dry weight of root(0.070 g), fresh weight of shoot (12.9 g) and dry weight of shoot (2.72 g). Hence the study suggested that, the cuttings grown in the media T7= (Cocodust + Vermicompost; 1:1) were apparently best for propagating of Black pepper cuttings.

Influence of different colored shade nets on the success and growth of black pepper cuttings in nursery

The study was undertaken in pepper nursery at Spices Research Sub-Station, Jaintapur, Sylhet during February to April 2019 with red, black, green, blue, white and yellow color shade nets (60%). Black pepper is a perennial spice crop which is conventionally propagated vegetatively using runner shoots produced from the base of the plant. The ideal time for raising pepper nursery is March to June. Most of the pepper nurseries are roofed with green shade nets (60%). Growth with respect to number of well-developed leaves and height of the plants was also higher under red shade net. The highest mean plant height of 32.26 cm was observed under red shade net and lowest under black shade net (25.37 cm). The highest mean number of well developed leaves per plant was observed under red shade net (12.67 nos.) followed by 11.35 nos. under black shade net and 10.27 nos. under green shade net. There was no significant difference in percent establishment of cuttings and number of nodes under different color shade nets. But plant mortality was significantly less under red shade net nursery. The study revealed that color of the shade net has an effect on growth parameters black pepper cuttings in nursery.

Chaba

Varietal development

Collection and evaluation of chaba (*Piper chaba*)

The experiment was conducted at the research field of Regional Spices Research Centre, Magura during kharif 1 season, 2018-19 to evaluate the performance of different Chaba germplasm and to select the promising one(s) for releasing as a variety. Six germplasm namely PCmag-001, PCmag-002, PCmag-003, PCmag-004, PCmag-005 and PCmag-006 were collected from khulna region of Bangladesh and transplanted into different tree species of Regional Spices Research Centre, Magura. Different morphological data on leaf shape, leaf color, average leaf length of leaf blade(cm), wide of leaf blade (cm), stem color, plant height (cm), number of branch, number of leaves,), internodes length (cm) and vine diameter (cm were recorded. Among the six germplasm heighest plant height (450 cm), number of branch (35), number of leaves (350), internodes length (16 cm) and vine diameter (2.5 cm) was recorded from PCmag-001 line followed by PCmag-002.

Other

Varietal development

Collection and evaluation of indigenous spices crop under Sylhet region

The study was conducted at Citrus research Station (CRS), Jaintapur, Sylhet. Different germplasm of eight different indigenous spices crop were collected from different location of Sylhet region. These germplasm are kept in controlled condition in net house and will be further evaluated will be done.

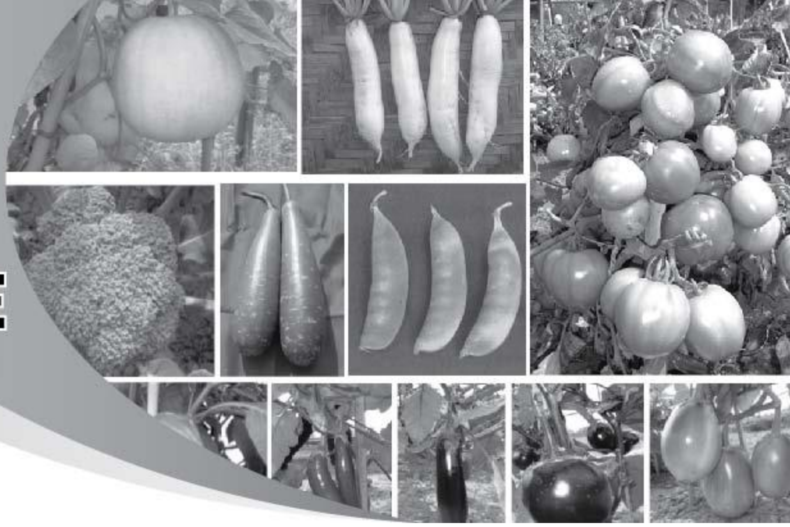
Collection, evaluation and conservation of aromatic and medicinal spice crops

Traditional and herbal medicines have attracted the attention of researchers all around the world and despite the development of synthetic drugs, demand for plant-based medicines is growing. The main reason for this growing trend is increasing public concerns about the adverse effects of synthetic medicines. Traditional medicine is two important issues that should be noted to achieve effective herbal medicines with considerable therapeutic effects. Traditional medicine is based on experience of people over centuries and ethno-botany is based on recognition of the native plants. Bangladesh has very high plant diversity because of its different climate, ecosystems and soil conditions. Regarding increasing demand for medicinal plants, this study aimed to collect some native plant varieties to know having the medicinal properties and to study the morpho-physiological behavior of spices and other crops. In the present study, the plant species were collected during years 2019-2020 and systematically identified. The traditional and local uses of collected plants were questioned through interviews with local people and healers. About 102 plant species were collected and identified. They had various therapeutic effects. Lamiaceae and Asteraceae families had the highest use among the collected plants. Herbal medicines in this area are mostly used to treat digestive and respiratory system disorders. They have economical values and should be studied and explored more detailed.

Cultural management

Performance study of selected spices, fruits and vegtables for roof top gardening

The experiment was conducted at Spices Research Centre, Shibganj, Bogura during 2019-2020 with a view to study the performance of some selected spices, fruits and vegetable crops for roof top gardening, to ensure year round supply of fresh spices, fruits and vegetables, effective utilization of space, to increases the monetary value of land/apartment and to facilitate clean environment. Different spices, vegetables and fruit crops were used in this study and the study is going on.



05 VEGETABLE CROPS

Eggplant

Genetic diversity of eggplant germplasm during for summer

The study was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur during the summer season of 2018 to assess the extent of genetic diversity among 21 eggplant germplasm. The collected germplasm originating from local and exotic sources were subjected to cluster analysis. The germplasm was constellated into five distinct groups with the range of 1 germplasm in cluster IV to 8 germplasm in cluster II. The inter-cluster distance in all cases was larger than the intra- cluster distance. Maximum inter-cluster distance (31.80) was observed between germplasm of cluster IV and V followed by cluster II and IV (30.50) and minimum was found between germplasm of cluster I and II (4.36). The highest intra cluster value (1.264) was observed in cluster II. Cluster V was constituted of four germplasm and exhibited lowest mean value for days to 1st harvest (92), FSB infested fruit (13.70 %), bacterial wilt infestation (1.67 %) and mean highest value for average fruit weight (136 g), plant height at 1st harvest (68 cm), while second highest value for number of marketable fruit (24.3), fruit yield (3.29 kg/plant), fruit yield (36.2 t/ha). Considering the group distance and inter-genotypic crosses between the members of cluster IV and V and cluster II and IV would exhibit high heterosis. But in case of the cluster means values and yield contributing performance cluster III, cluster IV and cluster V performed well. Therefore, inbred belong to cluster III, cluster IV and cluster V will be given higher priority for crossing in future hybridization programme.

Evaluation of eggplant lines for summer at Jamalpur region

The experiment was conducted at the research field of HRC, Regional Agricultural Research Station, BARI, Jamalpur during the summer season of 2019 to 20 to develop new high yielding OP variety. Twelve collected eggplant lines viz. SM Jam-001, SM Jam-002, SM Jam-011, SM Jam-012, SM Jam-013, SM Jam-014, SM Jam-015, SM Jam-016, SM Jam-018, SM Jam-020, SM Jam-021 and SM Jam-022 were evaluated at RARS, Jamalpur. The highest (90) number of fruits per plant was noted from the line SMJam-014 and the lowest (7) number of fruits per plant was noted form the line SMJam-016. The maximum yield (52.71 t/ha) was produced by the line SMJam-014 and the minimum yield (7.8 t/ha) was produced by the line SMJam-016. Considering high yield, EFSB infection, BW infestation tolerance, fruit shape and color the lines SMJam-016was found promising.

Preliminary yield trial of purple coloured eggplant lines for winter

A study on the performance of thirty-seven eggplant lines with BARI Begun-4 (as check) was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, during the winter season of 2019-20 to observe the performance of the selected lines. The early harvested lines were SM373 (94 days), SM354, SM361, SM383, SM402 (95 days), SM355, SM398, and SM403 (96 days). The heaviest fruit was produced in SM405 (253 g), followed by SM404 (247 g), SM403 (223 g), SM408 (215 g), SM407, SM 406, SM364A (213 g), SM361 (205 g), while the lightest fruit was produced by SM314 (71 g). The range of eggplant fruit and shoot borer infection was 6.67-20.67%, while the bacterial wilt infestation was 0.00-6.67%

mortality. Five types of fruit shape were observed viz., oblong (12 lines), elongate (7 lines), cylindrical (14 lines), round (3 lines), oval (2 lines), while 3 types of purple colored was observed viz., purple (19 lines), black purple (13 lines), deep purple (6 lines) among the 38 eggplant lines. Considering earliness, high yield, EFSB infection, BW infestation tolerance, fruit shape and color the lines SM310, SM313, SM322, SM325, SM327, SM337, SM354, SM373, SM405 were found promising.

Preliminary yield trial of green colored eggplant lines for winter

The study was conducted with 23 eggplant lines/ variety at the farm of Olericulture Division, HRC, BARI, Gazipur during the winter season of 2019-20 to develop new green type high yielding OP variety having tolerance to eggplant fruit and shoot borer and bacterial wilt. The lines varied significantly for their response to all characters ($P<0.05$). The range of days to first harvest was 95-105 days, while line SM 011 required minimum 95 days. The heaviest sized fruit was harvested by SM021 (287 g), while the range was 83-287g. The other bigger sized fruits were SM013 (256 g), SM275 (246 g), BARI Begun-6 (215 g), SM291B (211 g). The range of fruit infection by eggplant fruit and shoot borer (EFSB) was 8-23%, while equal or less than 15% infection was in ten lines. In case of bacterial wilt (BW) infestation at field level performance, zero percent incidences were observed in fourteen lines. The highest fruit yield was produced by SM275 (67.04 t/ha) with the range of 38.85- 67.04 t/ha, while the other higher yielder lines were SM 332 (59.26 t/ha), SM 253B (58.15 t/ha), SM 358 (54.74 t/ha), SM 334 (53.29 t/ha). Considering earliness, tolerance to fruit infection by EFSB, bacterial wilt infestation, attractive fruit shape and green fruit color, the lines SM83A, SM253B, SM275, SM332, SM334, SM358, SM369 were found promising. So these seven lines can be selected for further confirmation.

Advanced yield trialof eggplant lines for winter

A study on the performance of twenty-four selected advanced eggplant lines with BARI Begun-4 (as check) was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, during the winter season of 2019-20 to observe the performance. Among these 25 lines, SM 232 was the earliest (98 days), while the maximum number of fruit (36) was recorded by the line BARI Begun-4 which was at par with SM232-3, SM 232A1, SM232A-4 while the heaviest fruit was produced in SM181B (173.67g) and which was at par with SM293C which was statistically similar with SM217 (169.67 g). The longest fruits were produced by the line SM181E (23.30 cm) while the highest diameter fruit was recorded from SM293B and SM293C (9.83 cm). The calculated fruit yield was ranged from 26.61 to 56.79 t/ha. The lines SM232A-6 (56.79 t/ha), SM181E (56.28 t/ha),SM181B (56.23 t/ha), SM217 (54.86 t/ha), SM293 C (54.70 t/ha), SM293B (52.75 t/ha) and BARI Begun- 4 (52.64 t/ha) produced the highest yield per hectare. In case of fruit and shoot borer infestation, the minimum infestation by fruit and shoot borer was observed in SM232A-1 (10.33%) which was identical similar with BARI Begun-4 (11.00 %), while the maximum infestation was SM217 (19.33 %). Considering earliness, high yield, EFSB infection, BW infestation tolerance, fruit shape and colour the lines SM232A-6, SM181E, SM181B, SM236A, SM293C, SM293B were found promising and may be recommended for RYT.

Advanced yield trialof eggplant lines during summer

A study on the performance of seventeen selected advance eggplant lines with BARI Begun-8 (as check) was conducted at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, during the summer season of 2019 to observe the performance of the eggplant lines. The days to first harvest the range was 83.00- 99.00 days, while the highest number of marketable fruits/ plant was counted in SM011 (88) and heaviest fruits were produced in SM275 (167.22 g), SM253B (150.67 g), SM181E (144.55 g). The range of fruit yield/ plant was 1.98 - 4.39 kg, while the range of EFSB infection was 11.67 - 18.67 % and the lines viz., SM083A, SM083E, SM222C, SM222D, SM232, SM275, SM286B, and BARI Begun-8 showed field level tolerant against BW infestation (0.00%). Considering earliness, high yield, EFSB infection, BW infestation tolerance, fruit shape and color the lines SM011, SM286B, SM253B, SM275, SM181E were found promising and may be recommended for RYT during summer and rainy season.

Advanced yield trial of eggplant lines for winter at Jamalpur region

The study was conducted at the research field of HRC, Regional Agricultural Research Station, BARI, Jamalpur during the winter season of 2019-2020 to develop new high yielding OP variety. Five eggplant lines *viz*. SM Jam-003, SM Jam-011, SM Jam-015, SM Jam-017, SM Jam-024 and BARI Begun-6 as check were evaluated at RARS, Jamalpur. The highest (20.13) number of fruits/plant was counted from the line SM Jam-003 and the lowest (10.00) number of fruits from SM Jam-024. The longest fruit was recorded from SM Jam-003 (17.77 cm) and the shortest was from SM Jam-015 (13.09 cm). The heaviest fruit was found in SM Jam-015 (347.47 gm) and the smallest fruit was observed in SM Jam-003 (158.27 gm). Maximum yield (3.53 kg/plant and 41.22 t/ha) was produced by the line SM Jam-015 and minimum yield (2.48 kg/plant and 29.52 t/ha) was produced by SM Jam-017. Highest BSFB infested fruit were observed in BARI Begun-6 (5.77%) and lowest was in SM Jam-003 (2.60%). Considering high yield, EFSB infection, BW infestation tolerance, fruit shape and color the lines SM Jam-015 was found promising and may be recommended for RYT.

Regional yield trial of eggplant lines for winter

A study on the performance of ten eggplant lines with BARI Begun-4 and BARI Begun-6 as check was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur along with different RARS of BARI *viz*., Akbarpur, Hathazari, Ishwardi, Jamalpur, Rahmatpur, Iswardi, Burirhat, Cumilla of Bangladesh during the winter season of 2019-20 to develop new high yielding OP varieties. In case of days to 1st harvest, SM 216 was the earliest (100 days) while the highest marketable fruit/ plant were found in SM 233 (65). The highest average fruit weight was obtained from the line SM 407 (344.00 g). The range of fruit yield was 48.67 to 86.06 t/ha. The highest fruit yield was obtained from SM 407 (86.06 t/ha) and which was followed by SM216, SM 233, SM 405 (Purple colored) and SM 407, SM 220 (Green colored). Minimum infection by fruit and shoot borer was observed in ISD35 (13.00%). In field level performance, 0.00-3.33 percent bacterial wilt infestation was observed among the lines. Considering earliness, high yield and maximum tolerance level to fruit and shoot borer, bacterial wilt, the lines SM216, SM233, SM405 (Purple colored) and SM 407, SM 220 (Green colored) were found promising. By this time SM 407 has been released variety as BARI Begun-12. Among the rest lines, SM216, SM233, SM405 (purple color) SM 220, ISD 35 (Green color) may be recommended for another year trial.

Heterosis studies in green colored eggplant hybrids

A study was conducted in eggplant to estimate the magnitude of heterosis for yield and its nine yield related components. Twenty-one green colored eggplant hybrids generated from 7 × 7 diallel cross (excluding reciprocals) along with their green colored parents evaluated in a Randomized Block Design with three replications at Olericulture Division, HRC, BARI, Gazipur, Bangladesh. Appreciable heterosis was found over better parent for all the traits studied in desirable direction. In case of days to first harvest 19 hybrids showed significant negative better parent heterosis indicating earliness, while 13 hybrids showed significant positive heterotic response for number of marketable fruit with ranged from 8.00 to 55.29 per cent. There was significant observation in EFSB infected fruit and bacterial wilt infestation parameters. Considering days to 1st harvest, number of marketable fruit, average fruit weight, fruit length, fruit diameter, EFSB infected fruit, bacterial wilt infestation and fruit yield hybrids 11x12, 11x21, 11x221B, 12X13, 12X21, 12X221B, 21X221B performed higher better parent heterosis. The present study reveals good scope for isolation of pure lines from the progenies of heterotic F_1s as well as commercial exploitation of heterosis in eggplant.

Regional yield trial of green coloured eggplant hybrids

The study was conducted with five advance F_1's lines at the farm of Olericulture Division, HRC, BARI, Gazipur along with different RARS (Akbarpur, Jashore, Hathazari, Ishwardi, Jamalpur, Rahmatpur, Burirhat) of BARI during the winter season of 2019-20 to develop new high yielding hybrids having tolerance to eggplant fruit and shoot borer and bacterial wilt. The hybrids varied significantly for their response to all characters ($P<0.05$). The early harvested hybrids were F_1 21x11, F_1 204 Ax11 (101.33 days), while the highest number of marketable fruits per plant was counted by BARI Hybrid Begun-4 (37.21) and the heaviest fruit was produced in F_1 21x11 (147.33 g). Zero percent bacterial wilt incidences was observed in F_1 12x11, F_1 21x11, BARI Hybrid Begun-4, while the range of EFSB infection was 10.23 - 16.43 %. The higher fruit yield was recorded from the line F_1 204 Ax11 (55.34 t/ha) and F_1 13x12 (54.67 t/ha). Considering earliness, tolerance to fruit infection by EFSB, bacterial wilt infestation, attractive fruit shape and fruit colour, the hybrids F_1 204 Ax11 and F_1 13x12 were found promising. So, these two green colored hybrids viz., F_1 204 Ax11 and F_1 13x12 can be selected for releasing as new hybrid variety.

Regional yield trial of purple colored eggplant hybrids

The study was conducted with seven purple colored advanced F_1 lines at the farm of Olericulture Division, HRC, BARI, Gazipur along with different RARS (Akbarpur, Jashore, Hathazari, Ishwardi, Jamalpur, Rahmatpur) of BARI during the winter season of 2019-20 to develop new high yielding hybrids having tolerance to eggplant fruit and shoot borer and bacterial wilt. The lines varied significantly for their response to all characters ($P<0.05$). The highest number of marketable fruits per plant was counted by F_1 203X233 (52.23) followed by BARI Hybrid Begun-3 (43.23), F_1 14X233 (43.19) while the heaviest fruit was produced in F_1 203X5 (155.33 g) followed by F_1 18X233 (135.00 g). Bacterial wilt incidences were observed nil in F_1 203X5, F_1 203X14, F_1 203X233, BARI Hybrid Begun-3, while the range of EFSB infection was 11.00 - 16.98 %. The higher fruit yield was recorded from the line F_1 5X216 (62.83 t/ha), statistically similar with F_1 14X5 (61.54 t/ha), followed by F_1 14X233 (57.94 t/ha), F_1 18X233 (56.86 t/ha). Considering earliness, tolerance to fruit infection by EFSB, bacterial wilt infestation, attractive fruit shape and fruit color, the purple colored hybrids F_1 5X216, F_1 14X5 were found promising. So, these two purple colored hybrids viz., F_1 5X216, F_1 14X5 might be selected for releasing as new purple colored eggplant hybrid variety.

Effect of fruit bagging for EFSB free quality eggplant production

The study was conducted with 6 treatments viz., i) Imported brown bag ii) Local brown bag iii) Imported white bag iv) Tracing paper bag v) HDPE bag vi) Open fruit (control) to study the technical feasibility of bagging the eggplant fruits during production to protect them against eggplant fruit and shoot borer (EFSB). Fruits were bagged at fruit set time, and evaluated for days to 1st harvest, number of marketable fruit, aborted fruit (%), average fruit weight (g), fruit length (cm), fruit diameter (cm), fruit yield per plant (kg), eggplant fruit and shoot borer (EFSB) infection (%), spotted/ scratched fruits (%), fruit skin colour and fruit yield (t/ha). The highest average fruit weight (348.33 g) was obtained from fruits bagged with HDPE bag, followed by local brown bag (327.00 g), imported white bag (315.00 g), while lower weighed fruit was obtained from tracing paper bag (310.00g). Zero percent damage by eggplant fruit and shoot borer (EFSB) was observed in all treatments except the control treatment viz., open fruit where 20.00% infection was observed. The highest fruit yield was produced in imported white bag (58.37 t/ha), statistically similar with local brown bag (58.80 t/ha) followed by tracing paper bag (52.70 t/ha). The bagging of eggplant fruits with imported white bag, local brown bag and tracing paper bag were more effective in reducing damage by eggplant fruit and shoot borer than the other bagging treatments and the control. These three treatments produced higher number of consumers preferred fruit, without negative effects on the color of the skin, fresh weight and fruit abortion, thus resulting in higher economic gains.

Effect of different rootstock for higher eggplant production

A field experiment was conducted at Olericulture Division, HRC of BARI, Gazipur, Bangladesh, during the period from September 2019 to April 2020 to study the effect of different rootstock for higher eggplant production. Among the eight treatments, eggplant can be grafted on seven rootstocks viz., F_1 (13X12), EG203, SM262, SM275, BB-8, BB-10, SSwith desired scions-BARI Hybrid Begun-4 (BHB-4). There was significant differences found in the success rate among the cultivated and wild rootstocks. F_1 (13x12), BB-8 and BB-10 rootstocks, which had higher percentages of graft success 96%. Among the 7 grafted treatments, SS+BHB-4 (56.72 t/ha), SM262+BHB-4 (48.45 t/ha), F_1 (13x12)+BHB-4 (46.53 t/ha) produced more than 45 t/ha. So, these three rootstocks may be selected considering higher yield. However, the study was conducted during winter season. So, to draw a complete conclusion it is needed to conduct this experiment during summer season.

Screening of brinjal genotypes against salinity at germination and early seedling growth stage

The impact of three levels of sodium salt (NaCl) (0.0, 8.0 and 12.0 dS/M) on 11 eggplant varieties (V_1 = BARI Begun-1, V_2 = BARI Begun-4, V_3 = BARI Begun-5 V_4 = BARI Begun-6, V_5 = BARI Begun-7, V_6 = BARI Begun-8, V_7 = BARI Begun-10, V_8 = BARI Bt Begun-1, V_9 = BARI Bt Begun-2, V 10= BARI Bt Begun-3 and V_{11} = BARI Bt Begun-4) was studied at the laboratory of Plant Physiology Section, HRC, BARI, Gazipur to find out the salt tolerant brinjal genotypes at germination and early seedling growth stage. The experiment was conducted in CRD with three replications. Growth and germination parameters of brinjal varieties were investigated under salt stress. Results of this study showed a considerable decrease in growth criteria (seedling length, root length, seedling fresh weight and dry weight with the increase in salinity levels. In conclusion, eggplant genotypes showed variation in their response to salt tolerance and the three varieties BARI Bt begun-2, BARI Begun-1 and BARI Beugun-7 performed better at 8 dS/m salinity level compared to other varieties.

Screening eggplant germplasm for resistant to bacterial wilt

Twenty-one eggplant accessions were evaluated for resistance to *Ralstonia solanacearum* grown under artificial inoculated conditions during 2019-2020 cropping seasons. Two lines such as 20x11 and 1x12 gave highly resistant reaction under field condition in Gazipur. Wild *Solanum* (*Solanum sisymbriifolium),* two lines of eggplant i.e 11x220, 221Bx83B, BARI Begun-8 and BARI Begun-10 showed resistant reaction. Single line i.e. 233x20 showed moderately resistant reaction. Three lines showed moderately susceptible and six lines showed susceptible reaction where, four lines gave highly susceptible reaction to *R. solanacearum*.

Screening eggplant germplasm against root-knot nematode

Twenty eggplant varieties/lines were tested in a nematode infested sick bed for their resistance to root-knot nematode during 2019-2020 cropping season. Among them six lines *Solanum sisymbrifolium*, 12x21, 11x353, 4x359, SM-359-NS and 1x12 were found resistant, five lines 13x12, 11x220, 13x221B, 221Bx83B and 20 x11 gave moderately resistant, one line moderately susceptible, five lines were found susceptible, two lines were highly susceptible to root knot nematode.

Tomato

Multi-location yield trial of selected resistant tomato lines/genotypes against different insect pests and diseases

A multi-location yield trial was conducted on WVC (The World Vegetable Centre-former AVRDC) supplied tomato entries to study the yield, pest and diseases resistance and quality attributes at the experimental field and laboratory of Olericulture Division of HRC, BARI, Gazipur, Bangladesh (On-Station) along with six farmers field at Bogura, Thakurgaon and Panchagarh (defined as Bogura: Location-I included four farmers and Thakurgaon and Panchagarh-Location: II included two farmers) during the winter season of the year 2019-20. There were 5 selected tomato lines lines *viz.*: SL0403=CLN3900D-18B; SL0405= CLN3902D; SL0411= CLN3961C; SL0413= CLN3853C; and SL0416= CLN3902C along with one local check BARI Tomato -19 were included in this study.

Based on the on station results (results of Gazipur-HQ), the findings of major parameters revealed that: days to 50% flowering was observed uniform that was confined in 51.0-57.0 days. In respect of fruit number/plant the highest number of fruits (26.0) was counted in the line SL0SL0416 and the lowest number of fruits was counted in SL0411 (23.0). In the case of average fruit weight, the largest fruit was harvested from SL0403 (86.81g) followed by SL0413 (81.45g) and the lowest average fruit weight were obtained from SL0411 (62.45g). The marketable fruit yield/plant varied from 2.30 to 1.86kg. The highest marketable fruit yield (55.38 t) was obtained from the entry SL0413. Though the line SL0411 is low yielding (47.11 t) among the entries but due to its earliness, this line may be used in cropping pattern to increase cropping intensity. The length and width of fruits, TSS, P^H, pericarp thickness and locules number/fruit of different lines varied significantly. The line SL0413 exhibited the highest (10.0 days) shelf life at the ambient temperature of 26-27^{O}C. Number of seeds/fruit showed significant different among the lines studied which was ranged from 79.0 to 100.0. Most of the lines showed better performance in terms of pest and disease resistance. The yield performance at farmer's field over location revealed that except the line SL0411 other four lines showed higher yield but in spite of low yield the line SL0411 appeared to be as early and short period harvestable. An identical scenario was also recorded in on station trial. The mean yield was varied over locations, the highest average yield (56.81 t) was recorded from the field of farmer-02 of location-II while the lowest yield (48.18 t) was measured from the field of farmer-03 of location-I. The yield performance at other farmer's field was similar which ranged from 50.00 to 55.56 tons. In the case of quality attributes, the highest firmness (12.46 Newton) showed in the line SL0416 that indicated hardiness of fruit which may be good for distant transportation. Yield performance at farmer's field trial also indicated same yield trends. Regarding other qualitative traits, all the lines found to be promising. The experiment may be put into the regional yield trial at different agro-ecological zones of Bangladesh to confirm the results aiming to release as new dual purpose tomato variety.

Evalution of semi determinate tomato lines in net house

A study on evaluation of selected semi determinate tomato entries was conducted under the net house of Olericulture Division of HRC, BARI, Gazipur during the winter season of 2019-20. There were 8 selected tomato lines (selected from exotic and local sources) namely- SL0419, SL0420, SL0421, SL0422, SL0424, SL0504, SL0505, SL0507 and BARI Tomato-15 (as check) included for this study for selecting superior semi determinate tomato lines. All the lines showed difference in the most of the parameters studied. The line SL0419 contributed the highest per plant yield (3.10 kg) with good shelf life (16.00 days) having 29 days harvestable period. Above 2.75 kg of fruit yield was exhibited from three lines (SL0420, SL0507 and SL0514). Number of seed per fruit varied ranged from 76.00 to 143.00. Virus infection was recorded up to 0-7.00% at 75 days after sowing (DAS) under field condition. But no virus was infected in SL0419, SL0420, SL0421 and SL0422 tomato entries. Based on different traits, the entries-SL0419, SL0420, SL0504, SL0507 and SL0514 found to be promising and these tomato lines may be selected for advance yield trials under net house in the next year for further study.

Combining ability in summer tomato through line × tester method

The experiment involving eight lines, two testers and 16 crosses evolved through line x tester method was conducted to evaluate lines, and to determine general combining ability (GCA) and specific combining ability (SCA) effects in summer tomato. It was established in the research field of Vegetable Division of BARI, Gazipur during May to September, 2019. Significant general and specific combining ability variances were observed for the characters studied. Variances due to SCA were higher than GCA for all the characters studied except duration of harvest. Three lines and one tester were identified as good general combiners for combining high yield with desired horticultural characters. Significant GCA effect was observed in Line 4 for days to 50% flowering (D50%F) and yield per plant (Y/pl); Line 5 for D50%F and locule per fruit (Loc/ft); Line 7 for D50%F and Loc/ft; and Tester 2 for D50%F, fruits per plant (Ft/pl), yield per plant and hectare. Three cross combinations Line 4 × Tester 2, Line 7 × Tester 2 and Line 8 × Tester 1 manifested significant high SCA effects coupled with better per se performance relative to desired horticultural characteristics. These three hybrids may be more useful in a hybrid breeding program after investigation at different agro ecological zones.

Preliminary yield trial of tomato hybrids for winter

A study on preliminary yield trial of newly developed six hybrids was conducted at the experimental field of Olericulture Division of HRC, BARI, Gazipur during the winter season of 2019-20 to assess the yield potentiality for selecting suitable hybrids. In this study, selected six hybrids lines- P_1xP_3, P_1xP_5, P_1xP_6, P_2xP_7, P_2xP_8, P_3xP_5 were included and BARI Hybrid Tomato-5 was used as check and the treatment combinations were treated as T_1, T_2, T_3, T_4, T_5, T_6, and T_0 respectively. The most of the parameters were significantly differed among the tomato entries. The treatment T_6 produced the largest average fruit weight (58.56g). The same entry exhibited maximum yield per plant (2.69 kg) followed by 2.31 kg fruit harvested from the treatment T_4. The maximum marketable yield per ha was obtained from T_6 (81.21t) followed by 69.73t contributed by the hybrid line T_4. The mean value of virus infection under field condition at 75 DAS was counted 6 to 10%. The magnitude of virus infection at this stage was not so harmful for commercial harvest. Considering the yield performance, uniformity and other attributes, all the entries found to be promising. The experiment may be put into as advance or regional yield trial for confirming the results.

Preliminary yield trial of tomato hybrids for summer

A trial was conducted with newly developed eight summer hybrid tomato entries to evaluate yield potentials and tolerance level against bacterial wilt (BW) and virus under field condition at BARI during summer season of 2019. The treatment combinations were T_1 –P_1XP_8; T_2 –P_2XP_8 ;T_3- P_4XP_5; T_4- P_4XP_8; T_5- P_5XP_6; T_6- P_5XP_8, T_7- P_6XP_8, T_8- $P_7XP_8$and T_0- BARI-Hybrid-Tomato-4 (control). All the parameters were found to be significantly differed.). In respect of days to first and 50% flowering exhibited difference but that was confined between 44-47 and 48-53 days respectively. The number of flower cluster/plant and number of flower/cluster was also varied from 10.0 to 19 and 5 to 7, respectively. Though the entries exhibited the higher number flower clusters but fruit setting tendency was low because of high temperature. The maximum number of fruits/plant was counted from the control (31.0) while, the second highest number of fruit was counted from the hybrid T_8 (29.0) and the lowest number of fruit beard in the hybrid T_3 (13). With regard to fruit yield per plant, it was revealed that the highest yield was exhibited from the treatment T_8 (1.57kg) and control BARI Tomato-4 (1.29kg), while, the lowest yield was recorded in T_4 (0.77 kg). There were four hybrid combinations (T_1, T_6, T_7 and T_8) showed good yield which was confined to 33-38 tones. The incidence of wilt infection was the highest in T_5 (10%). The entries were confined between 6-8% only. The highest virus infection was recorded in treatment T_4 (12%), while other treatments comprises between 8-10%. Among the hybrid tomato entries, above mentioned combinations (T_1, T_6, T_7 and T_8) were considered to be suitable in terms of pest and diseases tolerance and horticultural traits and will be worthwhile to verify the performance in further trial as preliminary yield trial

Preliminary yield trial of saline tolerant tomato hybrids and screening against salinity

A study on preliminary yield trial of newly developed four hybrids was conducted at the experimental field of Olericulture Division of HRC, BARI, Gazipur during the winter season of 2019-20 to assess the yield potentiality for selecting suitable F_1. In this study, selected four hybrid lines *viz*., P_1xP_2 , P_1xP_3, P_1xP_6, P_4xP_5 were included and BARI Hybrid Tomato-5 was used as check while, treatment combinations were treated as T_1, T_2, T_3, T_4, and T_0 respectively and in laboratory experiment, the treatment combination were factor-A (: G1-P_1, G2-P_2, G3-P_3, G4-P_4, G5-P_5, G6-P_6, G7-P_1XP_2, G8-P_1XP_3, G9- P_1XP_4, G10- P_1XP_5, G11- P_1XP_6, G12- P_2XP_3, G13- P_2XP_4, G14- P_2XP_5, G15- P_2XP_6, G16- P_3XP_4, G17- P_3XP_5, G18- P_3XP_6, G19- P_4XP_5, G20- P_4XP_6, G 21- P_5XP_6, G22-BARI Hybrid Tomato-4, G23- BARI Hybrid Tomato-8 and G24- BARI Hybrid Tomato-10 and factor-B (salinity level: v_0 (with out-saline-control), V_1-100 and V_2-150 mM NaCl. The seeds of the tomato genotypes were obtained from the Olericulture Division of HRC, BARI, Gazipur and propagated in the hydroponic site of Plant Physiology Division, BARI, Gazipur. The most of the parameters were significantly differed among the tomato entries. The treatment T_0 (control) produced the largest average fruit weight (56.12g). The same entry exhibited the maximum yield/plant (2.31kg) followed by 2.29 kg fruit harvested from the treatment T_2. The maximum marketable yield/ha was obtained from T_4 (67.33t) followed by 66.43t contributed by the hybrid line T_0. The mean value of virus infection under field condition at 75 DAS was counted 0 to 4%. The magnitude of virus infection at this stage was not so harmful for commercial harvest. Considering the yield performance, uniformity and other attributes, all the entries found to be promising. The experiment may be as advance included saline prone area for confirming the results. In the case of saline tolerance test the plants exposed to salt stress presented a significant decline in leaf area, root and shoot length, fresh and dry weight of the plants parts, and the reduction rate was lower in G5, G1, G7, G10, G14 and G16 tomato genotypes than others. Under salinity stress, these genotypes reduced more Na+ and less K+, Ca+, K+/N+a and Ca+/Na+ ratio as compared to other genotypes. However, in examining the visual appearance G5, G1, G7 and G10 genotypes were in scale classes 1 and 2. Based on the findings, G5, G1, G7, G10, G14 and G16 tomato genotypes may be selected as relatively tolerant against salinity stress.

Regional yield trial of semi determinate tomato hybrids

A study on regional yield trial of newly developed five semi determinate hybrids was conducted at the experimental field of Olericulture Division of HRC, BARI, Gazipur and Regional Agricultural Research Station (RARS) *viz*. Burirhat, Jamalpur and Rahmatpur during the winter season of 2019-20 to assess the regional adaptability and yield potentiality. In this study, selected five semi-determinate type hybrids lines like P_3xP_8 (SD), P_4xP_8 (SD), P_5xP_8 (SD), P_6xP_8 (SD), P_7xP_8 (SD) were included and BARI Hybrid Tomato-9 was used as check and the treatment combinations were treated as T_1, T_2, T_3, T_4, T_5, and T_0, respectively. There were maximum (13) parameters significantly differed among the tomato entries. The treatment T_5 produced the largest average fruit weight (94.89g). The same entry exhibited maximum yield per plant (4.73 kg) followed by 4.53 kg fruit harvested from the treatment T_3. The maximum marketable yield/ha was obtained from the treatment T_5 (96.66 t) followed by 94.80 t contributed by the hybrid line T_3. Tomato fruit may be harvest about 45 days from the most of the entries. Considering the adaptability, yield performance, uniformity and other attributes, the entries T_3 and T_5 found to be promising. As this is first year result, therefore the experiment may be repeated in different agro-ecological zones of Bangladesh for confirming the results.

Regional yield trial of determinate tomato hybrids

A study on regional yield trial of four determinate hybrids was conducted at the experimental field of Olericulture Division of HRC, BARI, Gazipur and Regional Agricultural Research Station (RARS) *viz*.- Burirhat, Jamalpur and Rahmatpur during the winter season of 2019-20 to assess the regional adaptability and yield potentiality of these entries. In this study, selected four determinate type hybrids lines like P_1xP_2 (D), P_1xP_5 (D), P_1xP_6 (D), P_6xP_7 (D) were included and BARI Hybrid Tomato-5 was used as check while, treatment combinations were treated as T_1, T_2, T_3, T_4, and T_0 respectively. The Most of the parameters were significantly differed among the tomato entries. The treatment T_1 produced the largest average fruit weight (67g). The T_2 treatment exhibited maximum yield per plant (2.94 kg) followed by 2.93 kg harvested from the control. Maximum yield per ha was obtained from the treatment T_2 (69.58 t) followed by 63.77 t contributed by the treatment T_4. Considering the adaptability, yield performance, uniformity and other attributes, the entriesT_2 and T_4 found to be promising. The main feature of these entries is harvestable within short period of time that leads to fit in the cropping pattern for increasing cropping intensity. As this is first year result, therefore the experiment may be repeated in different agro-ecological zones of Bangladesh for confirming the results.

Regional yield trial of tomato lines for multiple disease tolerance

A regional yield trial of three selected advance disease tolerant tomato lines with BARI Tomato -14 and BARI Tomato-15 was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur, Bangladesh and four regional stations viz. Jamalpur, Burirhat, Jashore, Ishwardi during the winter season of 2019-20 to assess the regional yield performance of the selected lines. Significant variation was observed among the lines in respect of different characters studied. Fruit number/plant was varied from 22.0 to 39.0. The highest (39.00) number of fruit was counted in AVTO 1317 followed by AVTO 1229 (36), AVTO 1316 (34) which are statistically similar. Average fruit weight ranged from 77 to 97g among the studied lines, where the highest (97g) weight was measured in the line AVTO 1317 the lowest fruit weight was observed in check variety BARI Tomato-15 (77g). Studied entries showed the uniformity in fruit size. The maximum fruit yield/plant was obtained from the line AVTO 1317 (3.54 kg) followed by AVTO 1316 (3.28 kg), AVTO 1229 (3.27 kg) while the lowest fruit yield/plant was recorded from the check variety BARI Tomato-15 (1.84 kg). Corresponding per hectare yield showed the similar trend. The maximum yield/hectare was obtained from the line AVTO 1317 (103.8 t) followed by AVTO 1316 (92.3 t), AVTO 1229 (87.5 t) while the lowest yield was recorded from four variety BARI Tomato-14 (35.4 t) followed by BARI Tomato-15 (38.7 t). The low yield of check varsities may be due to virus infestation and low population of plant/per unite area. Plant height was varied ranged from 108.5 cm to 143.5 cm. The keeping quality attribute or shelf life was studied for the tomato lines and it was observed that the fruits were marketable up to 14.0-22.0 days, while AVTO 1317 line exhibited the highest shelf life (22.0 days) in ambient condition at the temperature of 25-27^{0}C. It was revealed that none of the tomato varieties under evaluation was infected by bacterial wilt. The magnitude of TYLCV infection indicated that no virus infection found to be occurred in the lines AVTO 1317, AVTO 1316 and AVTO 1229 except control BARI Tomato-14 which was 48% infection. The causes of virus tolerance may be due to genetic potentiality of the tomato entries. The result revealed that considering high yield and disease tolerance the tomato lines *viz*. AVTO1317, AVTO1316 and AVTO1229 were found to be promising. The experiment may be repeated for confirming the results.

Fruit retention effect on yield and seed quality of tomato

This investigation was carried out in winter seasons of 2019-20 using BARI Tomato-16 planted in Olericultural research field, HRC, BARI, Gazipur to study the response of fruit retention per plant treatments on yield and seed quality of tomato. The experiment was laid out in the randomized complete block design (RCBD) with 4 replications. Four treatment *viz*., 3 fruit retention treatments (20, 30, 40 fruits/ plant, containing 4-5 fruits/truss) and all fruit retention were randomly allotted in each block. Data on average fruit weight, length and diameter, marketable yield and total yield and seeds of 10 fruits per treatment from each replication were collected. Results showed that fruit retention per plant had limited effect on tomato yield and seed quality. Only reduced fruit number (T_1) increased the average fruit weight of tomato. The largest fruit obtained from T_1 (144g) followed by T_2 (98.33g). The fruit yields/plant as well as fruit yield/plot were found to the highest in T_4 (3.5kg and 69.90 kg, respectively). Fruit retention per plant did not have a significant influence on fruit length, fruit diameter, 1000-seed weight; percent seed germination, seedling dry weight and seedling vigor index. This is first year result. The experiment was suggested to repeat following year for confirming the results.

Year round performance of tomato lines and varieties

The experiment was conducted at the experimental field of Olericulture Division, BARI, Gazipur during 2019-20. BARI Tomato-14, BARI Tomato-15, BARI Tomato-18, BARI Hybrid Tomato-10 and five tomato lines *viz*. SL 009, SL 119, SL 313, SL 507 and P3-1 were selected for the trial. Significant variation was observed among the varieties/lines for different sowing dates in respect of different characters studied. BARI Tomato-14 required the highest days to 50% flowering in August (52) days, December (71) days, April (54) days and June (56) days sowing whereas BARI hybrid tomato-10 required the least days for October (50) days, February (38) days, April (40) days and June (45) days sowing. The highest percent fruit set was observed in BARI Tomato-18 for August (36%), October (56%) and December (48%) sowing and the lowest percent fruit set was observed in the line SL-507 for the same showing dates (15%, 33%, 14%). Harvest duration extended in August and December sowing for all the verities and lines. The line SL-009 produced the highest number of fruit for August sowing (36) followed by BARI Hybrid Tomato-10 (35) and BARI Hybrid tomato-15 (34). In October and December sowing BARI Hybrid Tomato-10 produced the highest number of fruit (42 and 36).The line SL-507 produced the lowest number of fruit for all sowing dates. The highest individual fruit weight wait was obtained by the variety BARI Tomato-18 in August sowing (97g) and October sowing (105g) but in December sowing the line SL-507 produced the highest (93g) individual fruit weight. The line SL-009 produced the highest number of fruit for August sowing (36) nos. followed by BARI Hybrid Tomato-10 (35) nos. and BARI Hybrid Tomato-15 (34) nos. In October and December sowing BARI hybrid tomato-10 produced the highest number of fruit (42 and 36). The line SL-507 produced the lowest number of fruit for all sowing dates. The result revealed that considering yield the varieties BARI Tomato-14, BARI Tomato-15, BARI Tomato-18 and the lines SL 009, SL 119 and P3-1 may be suitable for early and late winter cultivation. As this is first year findings, the experiment may be repeated for next year to confirm the result.

Effect of different mulches on growth and yield of tomato

The study was conducted at the experimental field of Regional Agricultural Research Station (RARS), Rahmatpur, Barishal during the winter season of 2019-20 to determine the effect of mulches on growth and yield of tomato. The treatments of the experiment comprised seven mulch materials *viz*., sawdust (5 cm thick), Coco dust (5 cm thick), rice husk (5 cm thick), water hyacinth (chopping and 10 cm thick), black polythene, white polythene mulch, blue polythene mulch with no mulch as control and BARI Tomato-15 as a variety. There were no statistically significant among the parameters of days to 1st flower initiation, das to 50% flowering, date of 1st harvest but significantly different among the other parameters. Mulching significantly increased the total number of fruits/plant of tomato over bare plants. The highest number of fruit was recorded in chopped water hyacinth mulch (30.84) and the lowest was in white polythene mulch (20.91). Similar trend was also found in single fruit weight, being the highest in chopped water hyacinth mulch (67.62 g). The lowest was in white polythene mulch (553.08 g). The highest yield was recorded from chopped water hyacinth mulch (92.84 t/ha) followed by black polythene mulch (82.92 t/ha) and the lowest was in white polythene mulch (61.85 t/ha). As this is first year result, the experiment may be repeated for confirming the results.

Screening of hybrid tomato genotypes against salinity at germination and early seedling growth stage

A lab experiment was carried out at the Plant Physiology Laboratory of HRC, BARI, Gazipur during 28 November-09 December, 2019 to find out the salinity tolerant tomato genotypes during germination and early seedling growth stages. The experiment was conducted in CRD with three replications. The response of 12 hybrid tomato varities (BARI Hybrid Tomato-4, BARI Hybrid Tomato-5, BARI Hybrid Tomato-7, BARI Hybrid Tomato-8, BARI Hybrid Tomato-9, BARI Hybrid Tomato-10, Rupashi hybrid, Sonali Hybrid, Bornali hybrid and Unnayan Hybrid, BARI Hybrid Tomato-11 and V_{12}= Mintoo hybrid) against three levels of salinity (0, 8 and 12 dS/m) were studied. The final germination percentage and seed vigour index along with other attributes were reduced with increasing the salinity levels. *Among 11 tomato genotypes*, BARI Hybrid Tomato- 11, BARI Hybrid tomato-9, BARI Hybrid Tomato-10 and Mintoo hybrid performed better at both 8 and12 dS/m during germination and early seedling stage. Therefore, it might be concluded that BARI Hybrid Tomato- 11, BARI Hybrid tomato-9, BARI Hybrid Tomato-10 and Mintoo hybrid might be salt tolerant at germination and early seedling growth stage.

Effect of polyethylene glycol induced drought stress on tomato genotypes at germination and early growth stages

A lab experiment was carried out at the Plant Physiology Laboratory of HRC, BARI, Gazipur during 22 March 21, 2019 to April 04, 2020 to find out the drought tolerant tomato varieties during germination and early seedling growth stages. The experiment was conducted in CRD with three replications. The response of 11 tomato varieties (BARI Tomato-2, BARI Tomato-11, BARI Tomato-14, BARI Tomato-15, BARI Tomato-16, BARI Tomato-17, BARI Tomato-18, BARI Tomato-19, BARI Tomato-20 and BARI Tomato-21) against four levels of polyethylene glycol (PEG) *viz*., 0, 5, 10 and 15% PEG were studied. The relative final germination percentage, other relative germination properties, relative growth characters and seed vigour index were reduced with increasing the PEG concentrations. *Among 11 tomato varieties*, BARI Tomato- 11, BARI Tomato-18, BARI Tomato- 20 and BARI Tomato-2 performed better at 15% PEG during germination and early seedling stage.. Therefore, it can be concluded that these four tomato varieties were moderately drought tolerant.

Effect of drought stress on growth and yield of BARI released tomato varieties under pot culture

The pot experiment was conducted at the Plant Physiology field of Horticulture Research Center, BARI during Novemberr, 2019 to March, 2020 to study the responses of BARI released tomato varieties to drought stress. The experiment was conducted in RCBD with three replications.Tomato plants of ten varieties (BARI Tomato-14, BARI Tomato-15, BARI Tomato-16, BARI Tomato-17, BARI Tomato-18, BARI Tomato-19, BARI Tomato-20, BARI Tomato-21) were grown under three different conditions of water availability i.e. controlled (100% FC), 70% (FC and 50% FC. The parameters studied were plant height, chlorophyll content (SPAD value), relative water content (RWC) (%), number of fruits/plant, individual fruit weight, fruit set% and yield/plant. All the parameters are negatively affected by 70 and 50% FC due to less water availability. In respect of the parameters studied, it might be concluded that, BARI Tomato-16, BARI Tomato-18 and BARI Tomato-20 performed better at less water availability condition**.** Based on the above results, it can be concluded that BARI Tomato-5, BARI Tomato-16 and BARI Tomato-18 performed better at drought stress than other varieties

Effect of drought stress on growth and yield of BARI released tomato varieties under field condition

The experiment was conducted at the Plant Physiology field of Horticulture Research Center, BARI during November 2019 to March 2020 to study the responses of BARI Released tomato varieties to drought stress. The experiment was conducted in RCBD with three replications. Tomato plants of eight varieties (V_1 = BARI Tomato-14, V_2 = BARI Tomato-15, V_3 = BARI Tomato-16, V_4 = BARI Tomato-16, V_5 = BARI Tomato-18, V_6 = BARI Tomato-19, V_7 = BARI Tomato-20, V_8 = BARI Tomato-21) were grown under two different conditions of water availability i.e. controlled and drought. The parameters studied were plant height, chlorophyll content, relative water content (RWC) (%), number of fruits/plant, individual fruit weight, fruit set% and yield/plant. All the parameters are negatively affected by drought due to less water availability. In respect of the parameters RWC and fruit yield/plant/ha, it might be concluded that BARI Tomato-18 and BARI Tomato-20 performed better at drought condition. Based on the above results, it can be concluded that BARI Tomato-18 and BARI Tomato-20 performed better at drought stress than other varieties. The experiment will be conducted for the next year for the conformation of the result.

Effect of vermicompost and other fertilizer on tomato production

The field trial experiments were undertaken in Horticultural Research field at RARS, Rahmatpur, Barishal during the winter season of 2019-20 to evaluate comparative efficacies of vermicompost developed by indigenous method on tomato plants. All total seven treatments were considered as-T_1-chemical fertilizer, FRG,2018; T_2- Vermicompost 8 t/ha; T_3-Compost 10t/ha; T_4- 50% chemical fertilizer +50% vermicompost; T_5-50% chemical fertilizer+50% compost; T_6-50% chemical fertilizer+25% vermicompost+ 25% compost; T_7-50% vermicompost+50% compost) and each treatment was with three replicates and BARI Tomato-16 was as a variety. The effect of organic and chemical fertilizer showed significant increase of the number of fruits per plant, individual fruit weight and yields in terms of fruit production in all the treatments in comparison to controlled one. In case of number of fruit per plant, the highest was observed in treatment T_2 (22.83) followed by treatment T_6 (22.04) and the lowest was observed in treatment T_3 (18.75). In case of individual fruit weight the highest was in treatment T_7 (91.73 g) followed by T_6 (87.91 g) and the lowest was in treatment T_1 (61.41g).The highest yield/hectare was found in the treatment T_6 (96.85 t/ha) followed by T_7 (93.24 t/ha) and T_5 (88.99 t/ha). The lowest yield/hectare was observed in the treatment T_1 (62.24 t/ha). So, from 1st year experiment, it may be concluded that 50% chemical fertilizer of recommended fertilizer dose along with 25% vermicompost of 8 t/ha and 25% compost 10 t/ha performed best result for tomato production.

Influence of zinc and boron as foliar application on the growth, yield and quality of summer tomato

The experiment was conducted at the research field of HRC, BARI during summer season of 2018 and 2019 to evaluate the effect of foliar application of zinc and boron on growth, flowering and fruit setting of summer tomato and to determine the suitable foliar application doses of Zn and B for higher growth, yield and quality of summer tomato production. The experiment was designed followed by RCB with three replications. Four foliar sprays with one control and one soil applied (check) treatments *viz*. T_1: Control; T_2: 9 ppm Zn (25-ppm $ZnSO_4$); T_3: 5 ppm B (25-ppm H_3BO_3); T_4: 4.5 ppm Zn (12.5-ppm $ZnSO_4$) + 2.5 ppm B (12.5-ppm H_3BO_3); T_5: 9 ppm Zn + 5 ppm B (25-ppm $ZnSO_4$ + 25-ppm H_3BO_3) and T_6: 4 kg Zn + 2 kg B as soil application (check) were used in the experiment. From two years study it was observed that foliar application of Zn and B application has significant effects on summer tomato production. Treatment T_4 with foliar application of 4.5 ppm Zn (12.5 ppm $ZnSO_4$) + 2.5 ppm B (12.5 ppm H_3BO_3) showed the best performance in terms of both yield and economic profitability. Maximum yields of 21.93 and 33.33 ton ha^{-1} were recorded with the treatment T_4 for the years, respectively. Also the higher fruit setting (16.7 and 17.6 fruit plant^{-1}), individual fruit weight (67.7 and 65.8 g) were found with T_4 treatment. Maximum gross margin (Tk. 1195562 and Tk.311862) was found in T_4 treatment followed by T_6 (Tk. 1113720 and Tk. 260420) and T_3 (Tk. 1074130 and Tk.260130). Maximum BCR (2.74 and 1.45) and MBCR (31.82 and 9.71) were found from T_4 followed by T_6 and T_3, respectively. Therefore, foliar application of Zn and B is more profitable than soil application in respect of yield as well as economic profitability of summer tomato production.

Effect of magnesium on growth, yield and quality of tomato

A field experiment was conducted at the research field of HRC, BARI, Gazipur during 2019-20 to estimate the effective doses of magnesium (Mg) for yield maximization and quality improvement of tomato (*Solanum Lycopersicum* L.). There were 5 treatments *viz*. T_1 = Control, T_2 = Mg 4 kg ha^{-1}, T_3= Mg 8 kg ha^{-1}, T_4= Mg 12 kg ha^{-1} and T_5= Mg 16 kg ha^{-1} along with the blanket dose of $N_{140}P_{45}K_{90}S_{15}Zn_4B_2$ kg ha^{-1} and cow dung 5 t ha^{-1}. The experiment was designed randomized complete block with three replications. Result reveal that significantly the highest marketable yield of tomato (70.2 kg ha^{-1})was achieved in treatment receiving of 12 kg Mg ha^{-1}and the most percent yield increment (32%) was in the same treatment. The highest TSS (^{0}Brix 4.38) and vitamin C (45.8 mg 100 g^{-1}) was found in T_4 treatment. The T_4 treatment exhibited the highest Mg uptake (291 kg ha^{-1}) and gross margin (Tk. 573443 ha^{-1}). Based on economics application of 12 kg Mg ha^{-1} was more beneficial (BCR=5.64).

Screening tomato germplasm for resistant to bacterial wilt

Nineteen tomato accessions were screened to find out bacterial wilt resistant source grown under artificial inoculated field conditions during 2019-20 cropping seasons. Among the accessions, four accessions, namely SL-0416, AVTO-1229, AVTO-1316, SL-0406 and BARI Tomato-19 gave highly resistant reaction against bacterial wilt. Thirteen accessions of tomato and BARI Tomato-14, BARI Tomato-15 showed resistant reaction to R. *solanacearum*.

Screening rootstock against bacterial wilt for grafting tomato

Six different rootstocks were screened to find out suitable resistant rootstock for tomato grafting bacterial wilt resistant source grown under artificial inoculated field conditions. Three rootstocks such as WSM0001 (*Solanum sisymbriifolium)*, WSM0004 (EG 203) and SM0005 (BARI Begun-8) gave resistant reaction with 5% and 10% mortality, respectively.

Screening rootstock against root-knot nematode for grafting tomato

Seven different rootstocks were tested in a nematode infested sick bed for their resistance to root-knot nematode for grafting tomato. Among them two lines WSS-0001 (*Solanum sysimbriifolium*) and *S. torvum* were found highly resistant, five lines WSM-0004 (EG-203), WSM-0005 (BARI Begun-8), WSM-0006(khag-1), WSM-0007(khag-2) and WSM-0008(khag-3) were found resistant to root-knot nematode**.**

Screening tomato germplasm against root-knot nematode

Eighteen tomato varieties/lines were tested in a nematode infested sick bed for their resistance to root- knot nematode during 2019-2020 cropping season. Among them, six lines (SL-0411, SL-0001, SL-0410, SL-0407, SL-0304 and SL-0311) showed resistant, eight lines (SL-0403, SL-0409, SL-0009, SL-0008, SL-0038, SL-0310, SL-0003 and SL-0406) showed moderately resistant, four lines (BARI Tomato-19, SL-0416, SL-0413, and SL-0405) showed susceptible reaction to root knot nematode.

Screening tomato germplasm for resistance to tomato yellow leaf curl virus disease

The experiment was conducted in Horticulture research field, BARI, Gazipur during winter 2019-20 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 27 tomato variety/ lines were evaluated including susceptible check. Eleven lines were resistant and ten were moderately resistant to disease. The highest yield was observed in SL-0009 (4.20 kg/plant) with 25% disease incidence followed by BARI Tomato-16 and SL-0001 with 25% and 16%, respectively disease incidence. No lines have been found immune to TYLCV in tomao. This is first time of the evaluation, therefore further trial necessary for confirmation the results.

Management of TYLCV of tomato through chemical and cultural means

The experiment was conducted at Horticulture research field, BARI, Gazipur during winter 2019-20 cropping season to select suitable management practice (s) for Tomato Yellow Leaf Curl Virus (TYLCV) disease of tomato. BARI Tomato-8 variety was used in the experiment. Two treatments viz., yellow polyethylene mulch and control (Admire) were evaluated. Between them, yellow polyethylene mulch reduced the maximum disease incidence and severity, and increased yield of tomato. Control (Admire) was given moderate disease incidence and medium yield regarding leaf curl symptom development on upper leaves and per hactore yield of tomato. Therefore, yellow plastic mulch may recommend controlling whitefly population and management of TYLCV disease in tomato.

Dissemination of bio-rational IPM package against tomato leafminer, *tuta absoluta* in Panchagarh regions of Bangladesh

Field experiment was started at Five Farmer's fields of Dabarbhangha and Ziabari villages under Haribhasa union, Panchagarhsadar upazila, Panchagarh district during February 2020 to disseminate and popularize developed IPM package and to motivate the farmers to adopt IPM package through field day and Training program. Applications of different treatments were started in February 17, 2019. But due to COVID-19 pandemic data recording and application of different treatment could not be continued.

Field screening of different BARI released tomato varieties against major insect pests

Fourteen BARI released tomato varieties were screened against major insect pests infestation during 2019-20 at research field of HRC, BARI, Gazipur. Of these, no variety was found resistant or tolerant against major insect pests of tomato. Five varieties namely, BARI Tomato-19, BARI Tomato-20, BARI Tomato-21, BARI Tomato-11 and BARI Tomato-17 varieties were found as less susceptible against major insect pests and high yielding varieties.

Sweet pepper

Evaluation of sweet pepper germplasm

The experiment was conducted at the experimental field of Olericulture Division, HRC, BARI during the winter season of 2019-20 with four sweet pepper germplasm namely CA0012, CA0025, CA040 and CA041 with two check varieties *viz*., BARI Mistimorich-1 and BARI Mistimorich-2 to evaluate their performance. All the parameters varied significantly among the different germplasm. There was significant difference in days to 1st harvest and range was 70-81 days and the germplasm CA041 was the earliest and took 70 days while fruit length and breadth varied from 8.63 to 9.02 cm and 4.45 to 6.07 cm, respectively. The highest number of fruits/plant was recorded from BARI Mistimorich-2 (6), and the lowest was recorded from CA041 (5). BARI Mistimorich-1 produced the heaviest fruit (170 g). Total Soluble Solid (TSS %) was ranged from 3.2 to 4.1, where the germplasm CA040 contained the highest TSS (4.1%). Though the calculated highest per hectare yield were recorded from BARI Mistimorich-2 (37.07 t/ha) and BARI Mistimorich-1 (36.77 t/ha), but among the germplasm, CA025 produced the maximum fruit yield (36.25 t/ha). Considering earliness, fruit size, fruit yield two germplasm *viz*., CA025 and CA041 exhibited significant relationship compare to other germplasm.

Advanced yield trial of sweet pepper lines

The experiment was conducted at the experimental field of Olericulture Division, HRC, BARI during the winter season of 2019-20 with four sweet pepper lines with one check BARI Mistimorich-1 to evaluate their performance. All the parameters varied significantly among the different lines except fruit length and average fruit weight. There was significant difference in harvest duration and range was 67-75 days and the line CA005 was the earliest and took 67 days. Fruit breadth varied 4.45 to 6.07 cm. The highest amount of fruits was counted in the line BARI Mistimorich-1 (6) and the lowest was in CA004 (4). The heaviest fruits was recorded in the line CA004 (182 g). The highest fruit yield/plant was recorded from BARI Mistimorich-1 (1.01 kg) followed by CA001 (0.88 kg) while others lines produced similar lower yield which was ranged from (0.71 to 0.77 kg). Among the lines, the little leaf infestation significantly varied from 0.00 to 13.33 where the line P7 had no visibility of little leaf infestation but the highest infestation was observed in CA004 (13.33).

Evaluation of sweet pepper hybrids

A yield trial of sweet pepper hybrids / variety was carried out at the experimental farm of Olericulture Division, HRC, BARI, Gazipur, Bangladesh during winter season of 2019-20 to identify high yielding sweet pepper F_1 varieties. Six sweet pepper hybrids/ varieties *viz*., Hybrid 1, Hybrid 2, Hybrid 3, Hybrid 4, Hybrid 5 and BARI Mistimorich-1 were included in the study. All the parameters varied significantly among the Hybrid 1. In case of days to harvest, the hybrid1 was the earliest and it took 67 days to harvest. The very important character was number of fruits, the highest number of fruits were counted in the BARI Mistimorich-1 (6) and which was followed by Hybrid 3, Hybrid 4 and Hybrid 5 while the minimum was 4 in Hybrid 1 and Hybrid 2. The heaviest fruits were recorded in the line Hybrid 1 (187 g), while the BARI Mistimorich-1 produced the least weight fruits (167 g). The little leaf infestation was demonstrated in all the hybrids except Hybrids 5 (0%) and BARI Mistimorich-1 (0%). The maximum yield/hectare were calculated in BARI Mistimorich-1 (34.93 t/ha) which was similar with hybrid 3 and followed by Hybrid 1, Hybrid 4 and Hybrid 5 while the minimum was recorded in Hybrid 2 (29.29 t/ha).

Broccoli

Advanced yield trial of selected broccoli lines

The experiment was conducted at research field of Olericulture Division, HRC, BARI, Gazipur during the winter season of 2019 - 20 with three selected OP broccoli lines and BARI Broccoli-1 was used as check to evaluate their performance. The lines BOI 018 and BOI 021 took minimum days (34 days) for curd initiation. The line BOI 015 took the longest days (55 days) to curd harvest while the others lines and the variety BARI Broccoli-1 took similar days to curd harvest which ranged 47-50 days. The highest curd length (18.83 cm) was recorded from the line BOI 015 followed by BOI-018 and BOI-021. Identical curd breadth were recorded from all the lines and the ranged was 16.67-18.43 cm. The highest whole plant weight (1.64 Kg) was recorded from the line BOI-018 and the lowest (1.08 kg) was from BARI Broccoli-1. The highest only curd weight/plant (718.20 g) was obtained from the line BOI 018. The highest marketable curd weight/plant (963.33 g) and the highest per hectare curd yield (17.53 t) were obtained from the line BOI 018. The lowest only curd weight/plant (284.07g), marketable curd weight/plant (380.87 g) and the lowest per hectare curd yield (8.58 t) was recorded from the variety BARI Broccoli-1. All lines were produced medium and compact curd while BARI Broccoli-1 produced small curd. The variety BARI Broccoli-1 produced green color curd while other three lines produced light green color curd. On the basis of uniform curd shape, compactness and yield the line BOI 018 and BOI 015 were selected for RYT to verify their yield potentiality in local climate.

Effect of spacing and de-heading on quality seed production of BARI broccoli-1

A two factorial experiment with nine treatment combinations was conducted at Agricultural Research Station (ARS), BARI, Pahartali, Khulshi, Chattogram during rabi season 2019-20 to find out the best production technology for broccoli seed. These two factors were spacing and curd management. In case of siliqua/ plant, the highest number of siliqua (2453) was obtained from treatment H_2S_2 (de-heading with 60 cm × 60 cm spacing) followed by treatment H_1S_2 (scooping with 60 cm × 60 cm spacing) (2054). On the other hand, treatment H_3S_3 (no de-heading with 50 cm × 40 cm spacing) produced lowest number of siliqua/ plant which was documented as 677. Treatment H_2S_2 (de-heading with 60 cm × 60 cm spacing) also provided the maximum seeds/ siliqua (9.40), 1000 seed weight (4.37 g) and yield (1.65 t/ha) .The highest length of siliqua (5 cm) was obtained from treatment H_3S_2 (scooping with 60 cm × 60 cm spacing) and the lowest length of siliqua (4.55cm) was obtained from treatment H_2S_3 (de-heading with 50cm × 40 cm spacing). Treatment H_3S_3 (no de-heading with 50cm × 40 cm spacing) provided lowest seeds/ siliqua (6.50). Treatment H_1S_3 (scooping with 50 cm × 40 cm spacing) produced not only the lowest 1000 seed weight (3.17g) but also the lowest yield (0.96 t/ha).

Standardization of talc base formulation of *Trichoderma viride* for disease management of broccoli

The experiment was conducted in Horticulture research field, BARI, Gazipur during November 2019-20 cropping season with broccoli (Green giant) 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) was tested. Control was maintained without any *Trichoderma* application. All *Trichoderma* treatment reduced disease incidence over control. The highest disease incidence was recorded in control treatment. Talc *Trichoderma* and maize bran ratio 1:5 reduced the maximum disease incidence (77.83%) over control. Cabbage diameter, single head weight and yield was the highest in 1:5 ratio of talc *Trichoderma* and maize bran. Yield increased over control was 59.99% in 1:5 ratios of talc *Trichoderma* and maize bran muxture.

Cabbage

Effect of vermicompost and chemical fertilizers on nutritional quality of cabbage

A field experiment was carried out at the research field of Bangladesh Agricultural Research Institute, Soil and water management section, HRC, BARI, Gazipur during 2019-20 to assess the effect of vermicompost on quality of cabbage as compare to inorganic fertilizer. The treatments used were: T_1 = 100% RD ($N_{115}P_{70}K_{125}S_{20}Zn_2$ kg ha^{-1}), T_2 = 75% RD + 4 t ha^{-1}VC, T_3 = 100% RD+ 3t ha^{-1}VC, T_4 = 75% RD + 3 t ha^{-1}VC, T_5 = Native fertility. The tested variety was Atlas 70. The experimental treatments were arranged in randomized complete block design with three replicates. Results revealed that the T_3 (100% RD+ 3 t ha^{-1}VC) produced the highest yield (98.88 ton ha^{-1}), TSS (5.93ºBrix), Vit-C (13.42 mg $100g^{-1}$) and firmness (0.9 Sq cm^{-1}) and the lowest yield (10.27 ton ha^{-1}) with TSS (5.57ºBrix), Vit-C (10.99 mg $100g^{-1}$), Firmness (0.36Sq cm^{-1}) was in control treatment (native fertility). An inclusion of 3 ton VC ha^{-1} with 75% RD can reduce 25% of chemical fertilizer. Integrated use of VC at the rate of 3 ton ha^{-1} with 75% RD of chemical fertilizer was found as the best combinations for improving cabbage yield and enriching organic matter content of soil.

Management of cabbage disease using tricho-compost and-tricho-leachate

The experiment demonstration was conducted to show the effectiveness of Tricho-products for disease management of cabbage at farmers' fields, Jessore during rabi season in 2019-20. Regardless of locations, mean head damage reduction over control was 60.18%. Both of the locations, marketable yield was higher in Tricho-compost treatment than control. Yield increased over control was 35.73%. Benefit Cost Ratio was higher in Tricho-compost treatment. BCR increased over control was 27.82%.

Cauliflower

Management of cauliflower disease using tricho-compost and-leachate

The experiment was conducted to find out the effectiveness of Tricho-products for soil borne disease management and yield of cauliflower at farmers' fields, Jashore, Bogura and Cumilla district Jessore during rabi season in 2019-20. Regardless of locations, crop damaged due to insect, pest and diseases were lower in Trichoderma treated plot than control. About 50.55% disease reduced due to application of Tricho-compost and Tricho-leachate. Mean marketable yield (n=6) of cauliflower was 32.48 tons in Tricho-compost incorporated soil, while it was only 25.50 tons in control. Marketable yield increased about 27.48% in Tricho-products applied treatment. Benefit Cost Ratio was 2.28 and 1.83 in Trichoderma and control, respectively. BCR increased over control 24.88% in Tricho-compost treated field.

Raddish

Screening of radish germplasm against salinity

The experiment was executed in on-station of Agricultural Research Station, Benarpota, Satkhira during *Kharif* 2019-20. The purpose of the study was to evaluate the performance of radish varieties in coastal saline area. Four radish varieties *viz*., BARI Mula-1, BARI Mula-2, BARI Mula-3 and BARI Mula-4 were taken as treatment materials in this experiment. Yield and yield attributes are significantly varied. Among four varieties BARI Mula-2 gave the highest yield (41.67 t/ha) while BARI Mula-1 produced lowest yield (28.21 t/ha). During crop growing period soil salinity ranged from 2.75 to 7.34 dS/m.

Bottle gourd

Genetic diversity of bottle gourd germplasm

The study was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur during 2019-20 to assess the extent of genetic diversity among 21 bottle gourd germplasm. The collected germplasm from Plant Genetic resources Centre (PGRC) of BARI were subjected to cluster analysis. The experiment was laid out in RCB design with three replications. Data on days to first harvest, fruit number/ plant, average fruit weight (kg), fruit yield (kg/plant), fruit length (cm), fruit diameter (cm), fruit yield (t/ha), fruit shape and fruit color were recorded from three randomly selected plants per plot. Plot means for 7 quantitative characters were used for the statistical analysis. Genetic diversity was studied following Mahalanobis's (generalized distance (D^2). Statistical analyses were carried out using GenStat 5 software. The germplasm was constellated into five distinct groups with the range of 2 germplasm in cluster IV and cluster V to 8 germplasm in cluster III. The inter-cluster distance in all cases was larger than the intra- cluster distance. The highest intra cluster value (2.25) was observed in cluster III, while lowest was in cluster IV (0.453). Maximum inter-cluster distance (16.76) was observed between germplasm of cluster III and IV. In case of the cluster means values and yield contributing performance cluster III, cluster V performed well. Cluster III had eight germplasm and was responsible for highest mean for average fruit weight (2.27 kg), fruit yield /plant (16.81 kg), fruit length (36 cm), fruit yield (41.97 t/ha). Considering the group distance cluster III showed maximum genetic distance with cluster IV (16.756) followed by the genetic distance from cluster I with IV (13.285) and cluster IV with V (13.22) suggesting wide diversity, so inter-genotypic crosses between the members of cluster III with IV, cluster I with IV and cluster IV with V would exhibit high heterosis and is also likely to produce new recombinants with desired traits. In case of the cluster means values and yield contributing performance cluster I, cluster II, cluster IV and cluster V performed well. Therefore, inbreds belong to cluster I, cluster III and cluster V will be given higher priority for crossing in future bottle gourd hybridization programme.

Evaluation of bottle gourd germplasm in summer

A study was conducted to evaluate bottle gourd (*Lagenaria siceraria*) lines in respect of yield and quality in summer at HRC field, RARS, Jamalpur during the *kharif*-1 season of 2019 in order to release a new summer bottle gourd variety. Eight bottle gourd lines viz. LS Jam-001, LS Jam-002, LS Jam-003, LS Jam-004, LS Jam-006, LS Jam-007 , LS Jam -008 , LS Jam -009and BARI Lau-4 as check were evaluated to investigate the yield and yield contributing characters. The experiment was laid out in a RCBD design with three replications. The plot size was 10 m×2.5 m with a planting space of 2.5 m ×2.0 m. Twenty days old seedlings were transplanted in the field on 12 March, 2019. Each plot contained 5 plants. Recommended doses of fertilizers were used according to recommended method. Irrigation and other intercultural operations were done as and when necessary. Data were recorded on days to 1st female flowering, days to 1st harvest, days to last harvest, number of fruits/plant, fruit length and diameter, fruit yield/plant, fruit yield/plot and per hectare. Data in respect of vegetative, yield and fruit characters were recorded and measured characters were statistically analyzed following a programme Statistical Tools for Agricultural Research (STAR Longer fruit (45 cm) was obtained from LS Jam -004 whereas shorter fruit (13 cm) by LS Jam-007. LS Jam-008 produced wider fruit (17 cm) compared to narrower fruit (9.8 cm). The highest number of fruits per plant (10.20) was produced by the LS Jam-007 whereas the lowest number of fruits (5.2) was noted from the LS Jam-008. The higher individual fruit weight (1.55 kg) noted in LS Jam-001 and lower (1.38 kg) in LS Jam-003. The maximum fruit yield/plant (15.06 kg), per plot (75.30 kg) & per hectare (25.10 t) was produced by the LS Jam-001 and LS Jam-007 gave the second highest as against the less 7.27kg per plant , 36.33 kg/plot & 12.11 t per hectare in LS Jam-008.

Regional yield trial of bottle gourd lines

A regional performance trial of 4 bottle gourd lines namely LS146 A1, LS151 C, LS154, LS171 with BARI Lau-3 and BARI Lau-4 were carried out to assess the adaptability of the advanced lines as to develop new high yielding OP varieties. The experiment were set at Olericulture Division, HRC, BARI, Gazipur, RARS, Akbarpur, Hathazari, Ishwardi, Jashore, Jamalpur, Rahmatpur and Burirhat, and RHRS, Patuakhali of Bangladesh during the winter season of 2019-20. The experiments were laid out in a RCB design with 4 replications in every location. The unit plot size was 10.0 x 2.0 m maintaining 2.0 x 2.5m spacing and 0.5m drain. Recommended doses of fertilizers were used according to recommended method. The intercultural operations (weeding and irrigation etc.) were done as and when necessary. Data on days to first harvest, fruit number/plant, average fruit weight (kg), fruit yield (kg/plant), fruit length (cm), fruit diameter (cm), fruit yield (t/ha), fruit shape and fruit color were recorded from three randomly selected plants per plot. In Gazipur, days to 1stharvest, number of fruits per plant, average fruit weight all characters showed insignificant. Highest fruit length (36.50 cm) was recorded in LS151C, while maximum fruit diameter was recorded in LS146 A_1 (20.33cm). The average highest yield of all locations was calculated in LS171 (47.92 t/ha), followed by BARI Lau-4 (46.75 t/ha) and LS154 (42.28 t/ha). Therefore, considering earliness, yield potentiality, fruit color, and acceptable fruit shape two advanced lines *viz*., LS 171 and LS154 were found promising and may be released as new bottle gourd varieties.

Heterosis study in bottle gourd

An intensive study was conducted in bottle gourd to assess the magnitude of heterosis for yield and its five yield related traits. Twenty one bottle gourd hybrids generated from 9 parents (excluding reciprocals) along with their nine parents evaluated in a RCBD with three replication at the Olericulture Division of HRC, BARI, Gazipur, Bangladesh during 2019-20. The seeds were sown on the seedbed on 01October, 2019. Twenty days old planting materials were placed in the main field on 21 October, 2019. Each planting material was represented by a single row of 10 m length. Row to row and plant to plant distance was 2.5m and 2m, respectively with 0.5m drain. Recommended doses of fertilizers were applied following recommended method. The recommended necessary agronomic practices and plant protection measures (especially adult red pumpkin beetle, fruit fly) were adopted for raising a good crop. GI steel pipes were used to support the growing plants and allowed them to grow along string netting. Irrigation was applied as and when required. Data were recorded on the following parameters *viz*., days to 1st harvest, fruits number per plant, average fruit weight, fruit length, fruit diameter and fruit yield (ton/ ha). All the quantitative data taken were subjected to ANOVA. The total variances of each character were partitioned into block, genotype and error differences. The differences within the classes of effects were tested by F-test. Percent heterosis was estimated as – H (BP) = $\{[(F_1 – BP) x100] / BP\}$ [when BP for better parent, H for heterosis]. Where, F_1 = Mean of F_1 generation, BP = Mean of better parent. The maximum cross combinations were found significant heterobeltiosis for earliness. The outstanding crosses were 1x146, 1X162, 1x4 (days to 1st harvest), 146X3, 4X142, 4x162, 4x1, 146X2 (fruits number per plant), 1x2, 1x3, 2x3 (average fruit weight), 3x151C (fruit length), 1x3 (fruit diameter), 162x2, 4x1, 4X142, 4x162, 3X162, 146X3, 1x2, 1X162, 1x4 (yield per plant) may be considered for selection. The presence of high heterosis indicated genetic diversity among parents. Considering earliness, number of fruits, size of fruits and fruit yield the hybrids viz., 1x2, 1X162, 3X162, 4x1, 4X142, 4x162, 146X3 and 162X2 were selected for advance trial.

Regional yield trial of bottle gourd hybrids

The performance study of four bottle gourd hybrids was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur along with different RARS/RHRS (Akbarpur, Hathazari, Ishwardi, Jamalpur, Rahmatpur, Patuakhali) of Bangladesh during the winter season of 2019-20 to develop new high yielding bottle gourd hybrid varieties. Four bottle gourd hybrid *viz*., F_1 3x4, F_1 2x146, F_1 4x3, F_1 139x4. The seeds of these lines/ varieties were sown on the polypot on 10 September, 2019. Fifteen days old seedlings were transplanted in the main field on 25 September, 2019. The experiment was laid out in a RCB design with 5 replications. The unit plot size was 10.0 x 2.0 m maintaining 2.0 x 2.5m spacing and 0.5m drain. Recommended doses of fertilizers were applied following recommended method. The intercultural operations (weeding, irrigation, crop protection measures etc.) were done as and when necessary. Data on days to first harvest, fruit number/ plant, average fruit weight (kg), fruit yield (kg/plant), fruit length (cm), fruit diameter (cm), fruit yield (t/ha), fruit shape and fruit color were recorded from three randomly selected plants per plot. Plot means for 7 quantitative characters were statistically analysis using MSTAT C software. In case of days to 1stharvest, the earliest hybrid was F_1 2x146 (82.33 days), while the maximum number of fruits/plant (9.56) was produced in F_1 3x4. The heaviest fruit was produced in F_1 4x3 (2.47 kg), followed by F_1 3x4 (2.30 kg). Considering earliness, yield potentiality, fruit color, acceptable fruit shape two advanced lines *viz*., F_1 3x4 and F_1 4x3 were found promising and may be released as new hybrid bottle gourd varieties.

Screening of bottle gourd varieties against salinity

An experiment was conducted at the Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during winter season, 2019-20 to find out the suitable bottle gourd varieties for cultivation in saline area. There were five bottle gourd varieties *viz*., BARI Lau-1, BARI Lau-2, BARI Lau-3, BARI Lau-4 and BARI Lau-5. The unit plot size was 4 m x 4 m. recommended fertilizer doses were used following recommended method. Twenty days old seedlings of bottle gourd were transplanted on 15 January, 2020 maintaining 2m x 2m spacing. Weeding was done and irrigation was given as and when necessary. White fly infestation was observed and it was controlled by spraying imitaf four times keeping 10 days intervals at the rate of 1 ml/L. Fruits were harvested on 22 March to 07 May, 2020. Yield and yield components of bottle gourd were recorded and data were analysed by MSTAT-C software programme and means were separated by Duncan's Multiple Range Test (DMRT).The maximum fruit yield was recorded in BARI Lau-4 (83.89 t/ha) which was statistically significant than other varieties and followed by BARI Lau-3 (58.95 t/ha), while the minimum in BARI Lau-5 (44.54 t/ha). During the crop growing period soil salinity ranged from 1.95 to 7.02 dS/m.

Evaluation of bottle gourd genotypes for drought tolerance through yield-based selection indices

Identification of drought-tolerant crop genotypes is fundamental to enhance productivity and for effective breeding and conservation. A field trial with 10 bottle gourd genotypes *viz*., BARI Lau-2, BARI Lau-3, BARI Lau-4, BARI Lau-5, LS 158, LS151C, Diana, Mayna, Green line and LS167 was conducted at the Research field of Plant Physiology section, HRC, BARI to determine drought tolerance of a set of bottle gourd genotypes and to identify promising genotypes for direct production or breeding. The study was carried out using a 10 × 2 factorial (split-plot) experiment involving 10 bottle gourd genotypes under drought-stressed (DS) and non-stressed (NS) conditions. Significant differences were observed among bottle gourd genotypes with respect to fruit yield under drought stress (DS) and non-stress (NS) conditions. The mean fruit yield under DS and NS conditions was 22.40 and 41.65 t/ha, respectively. Drought stress reduced fruit yield by 46.02%. Principal component analyses revealed the significance of yield-based indices of drought tolerance, such as geometric mean productivity, stress tolerance index, mean productivity, yield index and harmonic mean, which allowed discrimination of drought-tolerant bottle gourd genotypes. The three genotypes LS158, Diana and BARI Lau-4 were identified as drought tolerant genotypes for drought tolerance breeding or rootstock development programs.

Development of IPM package for gummy stem blight disease management of bottle gourd

The experiment was conducted at vegetable research field in HRC, BARI, Gazipur during the winter, 2019-20. Three treatments, *viz*., T_1= i) IPM package I: Soil application of Tricho-compost @ 2.5 t/ha + Bordeaux paste at 12 inch from soil level + foliar spray of Tricho-leachate @ 0.2% at 15 days interval + Pheromone trap, T_2= ii) IPM package II: Soil application of Talc base *Trichoderma* @ 50 kg/ha + mustard oil extract cake @ 600 kg/ha + foliar spray of Tricho-leachate @ 0.2% 0.2% at 15 days interval + Pheromone trap and iii) Control (regular practices) were used. Among the treatment, IPM package II: Soil application of Talc base *Trichoderma* @ 50 kg/ha + mustard oil extract cake @ 600 kg/ha + foliar spray of Tricho-leachate @ 0.2% at 15 days interval + Pheromone trap reduced the maximum disease incidence of gummy stem blight and increased the yield of bottle gourd followed by IPM package I: Soil application of Tricho-compost @ 2.5 t/ha + Bordeaux paste at 12 inch from soil level + foliar spray of Tricho-leachate @ 0.2% at 15 days interval + Pheromone trap was also found satisfactory to control the disease.

Pumpkin

Observation yield trial of pumpkin genotypes

Nine pumpkin genotypes were collected from PGRC and different location of Bangladesh on the basis of individual fruit weight which was evaluated at Olericulture Division, HRC, BARI, Gazipur during the winter season of 2019 - 20 to identify the bigger size pumpkin. The experiment was carried out in a RCB design with 3 replications. Seeds were sown in poly bag on November 15, 2019. The unit plot size was 2.0 × 12 m maintaining 2 × 2 m plant spacing within the bed. Fifty cm drain was kept between the plots. The land was fertilized with recommended doses of fertilizers. The intercultural operations were done as and when necessary. Eight quantitative and qualitative characters were measured which were days to 1st male flower (DMF), days to 1st female flower (DFF), node order to 1st male flower (NMF), node order to 1st female flower (NFF), fruit length (FL), fruit breadth (FB), fruits/plant, flesh thickness (Fl thick) average fruit weight (AvFwt.), yield/plant, yield (t/ha) and total soluble solid in percent (TSS%). The genotypes varied for their response of some characters studied. Most of the genotypes beard their male and female flower earlier and lowest node. The flesh thickness, average fruit weight, fruits per plant, yield per plant and yield (t/ha) was ranged from 3.08 to 4.67cm, 3.57 to 5.23 kg, 2.67 to 5.67, 10.67 to 21.67 kg and 21.33 to 43.33 ton, respectively. The TSS ranged from 7.50 to 11.53 %. The genotypes were in different shapes such as round, high round, elliptical and bumble. The orange type flesh color was dominant among the genotypes. Fruit fly infestation and virus incidence was also observed in these genotypes. All the collected lines were above 3.5kg and among them two genotypes (CM002 and CM CM007) showed more than 5 kg average fruit weight. So these lines may be used for breeding purpose for developing bigger size pumpkin varieties.

Evaluation of pumpkin germplasm

The experiment was conducted at the research field of HRC, RARS, BARI, Jamalpur during winter season of 2019-2020 to develop new high yielding OP variety. Thirty two collected pumkin lines were evaluated at RARS, Jamalpur. The experiment was laid out in non-replicated design. The unit plot size was 4.0 × 2.0 m and seedlings were planted maintaining a spacing of 2.0 × 2.0 m. The land was fertilized with recommended doses of fertilizer. The intercultural operations were done as and when needed. Data on days to 1st female and male flowering, node order of 1st male and female, number of fruits/plant, fruit length, fruit breadth, average fruit weight , flesh thickness, yield/plant, yield (t/ha) and TSS (%) were recorded. The data were analyzed statistically to assess the result. Highest number of fruits/plant was obtained from CM Jam-002 ((9). The line CM Jam-025 exhibited the longest fruit (39.00 cm) compared to the shortest fruit in CM Jam-031 which was 10 cm. CM Jam-003 demonstrated the narrowest fruit (33.34 cm) while the line CM Jam-011 had the widest fruit (75.50 cm). The line CM Jam-025 got the highest average fruit weight (5.48 kg) as against the lowest (1.27 kg) in CM Jam-013. Flesh thickness was the maximum (7.8 cm) in the line CM Jam-020 and CM Jam-037 and the minimum (3.8 cm) in CM Jam-041. The line CM Jam-025 produced the highest yield (21.92 Kg/plant and 54.80 t/ha) and the line CM Jam-011 produced the 2nd highest yield (14.40 Kg/plant and 36.00 t/ha) while CM Jam-030 had the least yield (2.74 kg/plant and 6.85 t/ha).

Inbred development in pumpkin

The trial was conducted at the experimental field of Regional Agricultural Research Station, BARI, Cumilla in winter 2019. Fifteen pumpkin lines were advanced from S_0 generation to S_1 generation to develop variable inbred lines for the development of good hybrid varieties. Twenty days old seedlings were transplanted in well prepared experimental plot with 2m x 3m plant spacing. It was a non-replicated trial. The land was fertilized with recommended doses of fertilizer. Standard agronomic practices were followed as and when necessary. Selfing and selection process were followed on the basis of crop improvement procedure. Selected plants were selfed. Selfing was done at anthesis at different days. Seeds of selfed fruits were stored for advancing next generation. Observations were recorded from all the plants in each plot for 14 characters. Data were recorded for days to 1st female flower opening, node order of 1st female flower opening, fruit length, fruit diameter, flesh thickness, average fruit weight, fruits/plant, yield/plant, yield, TSS (%), virus incidence(%), fruit shape, skin color and flesh color.Variations were found among the lines for the characters studied. The genotype CM Cum 007.2.3 required the minimum days to female flower opening (47 DAS), in opposite to the check BARI Mistikumra-2 which took the maximum days (80 DAS). The node order of first female flower ranged from 19 to 34. But in this regard, the node order did not show any relation to days to flowering in most cases. The largest fruits were found in CM Cum 004.2.2 (29 cm x 28 cm), which also possessed the maximum flesh thickness of almost 6.60 cm and led to the heaviest weighed fruit (9.50 kg). CM Cum 007.2, CM Cum 015.3, CM Cum 016.1 and BARI Mistikumra-2 produced comparatively smaller fruits (2.5-3.0 kg). In case of fruit number, BARI Mistikumra-2 produced the maximum (10) with average yield per plant 27.45 kg. On the other hand, CM Cum 007.2.3 and CM Cum 003.2 gave the highest yield (38.35 kg/plant) with a good number of fruits (9 & 6, respectively). The TSS% ranged from 4.5-9. CM Cum 004.3 and CM Cum 005.1 possessed the highest TSS content. Furthermore, the highest virus incidence about 30 % was found among the genotypes. Some genotypes were found apparently virus free viz. CM Cum 003.2.2, CM Cum 004.1, CM Cum 007.2

& CM Cum 007.2.3. Best individuals from every line of pumpkin were selected and selfed. Seeds of S_0 to S_1 progenies of pumpkin lines were stored for advancing S_1 to S_2 progenies in the next year.

Collection and evaluation of pumpkin germplasm in winter

Twenty pumpkin genotypes, collected mostly from PGRC (Plant Genetic Resource Centre), BARI were evaluated for screening lines having high yield potentiality and quality at RARS, BARI, Cumilla along with a check BARI Mistikumra-2 during *rabi* season, 2019-20. The unit plot size was 6.0 m x 2.0 m maintaining 2.0 x 2.0 m plant spacing. Pit size was 50 cm x 50 cm x 50 cm. Twenty days old seedlings were transplanted in well prepared experimental plot. It was a non-replicated trial. The land was fertilized with recommended doses of fertilizer. Standard agronomic practices were followed as and when necessary. Observations were recorded from all the plants in each plot for 14 characters. Data were recorded for days to 1st female flower opening, node order of 1st female flower opening, fruit length, fruit diameter, flesh thickness, average fruit weight, fruits per plant, yield/plant, yield, TSS (%), virus incidence(%), fruit shape, skin color and flesh color. Selfing and selection process was followed on the basis of crop improvement procedure. Seeds of selfed fruits were stored for advancing next generation. Results revealed that most of the germplasm performed better compared to check regarding fruit yield and other yield contributing characters. In respect of earliness, all the tested materials showed better performances than that of check. Specially, BD-322 took only 41 days to induce 1st female flower. The variation of node order of 1st female flower opening among different germplasm ranged from 13 to 33. Flesh thickness was found the highest in BD-277 (6.2 cm) and the lowest in BD-273 (3.00 cm). The highest no. of fruits/plant was found in BD-309 (24) followed by BD-2153.1 (12.00) and BD-2153.1 (10). BD-274.1 produced the highest average fruit weight (8.68 kg) but no. of fruits was only 4. But BD-309 was the best yielder (100.40 t ha^{-1}), as it produced fruits of average weight of 3.47 kg in a huge number (24). . In addition to that, all genotypes except BD-277, BD-274.1 and BD-273 found promising and gave higher yield than BARI Mistikumra-2 (45.84 t/ha). Flesh color was found light orange to deep orange. The highest TSS content was found in BD-2212 (12%) followed by BD-268 (10%) and BD-274.1 (9 %) and it was minimum (4 %) in BD-2153.1 and BD-264. Virus incidence ranged from 5%-50%. It was found most severe in BD-277 (50%). Depending on all the selection criteria some clones (15) were found promising and can be selected for advancing in the next generation e.g. BD-2212, CM Cum- 004.1.1, BD-288, BD-309, BD-2150, BD-2153, BD-2153.1, BD-2157, BD-2174, BD-2277, BD-322, BD-268, BD-274.1, BD-273 and BD-269.

Collection and evaluation of pumpkin germplasm in summer

Ninteen locally collected pumpkin genotypes were evaluated for screening lines having high yield potentiality and quality in summer season at RARS, BARI, Cumilla along with a check BARI Mistikumra-2, 2019. The unit plot size was 6.0 m x 2.0 m maintaining 2.0 x 2.0 m plant spacing. Pit size was 50 cm x 50 cm x 50 cm. Twenty days old seedlings were transplanted in well prepared experimental plot. The land was fertilized with recommended doses of fertilizers following recommended method. Standard agronomic practices were followed as and when necessary. Observations were recorded from all the plants in each plot for 13 characters. Data were recorded for days to 1st female flower opening, fruit length, fruit diameter, flesh thickness, average fruit weight, fruits/plant, yield/plant, yield, TSS (%), virus incidence(%), fruit shape, skin color and flesh color. Results revealed that most of the germplasm performed better compared to check regarding fruit yield and other yield contributing characters. In respect of earliness, all the tested materials showed better performances than the check. Specially, CM Cum 003.2 took only 48 days to induce 1st female flower. Flesh thickness was found highest in BD-277 (6.2 cm) and the lowest in BD-273 (3.00 cm). The highest no. of fruits/plant was found in CM Cum 009.3 (8) which eventually gave the highest yield with average fruit weight of 1.95 kg followed by CM Cum 002.1 (19.81 kg) and CM Cum 010.3 (19.04 kg). CM Cum 003.2 produced the highest average fruit weight (3.70 kg) but no. of fruits was only 3. In addition to that, all genotypes except CM Cum 004.1, CM Cum 012.2 and CM Cum 014.2 were found promising and gave comparatively higher yield than BARI Mistikumra-2 (8.02 t/ha). Genotypes varied according to their fruit shape, skin color and flesh color widely. Flesh color were found light yellow to deep orange. The highest TSS content was found in CM Cum 004.1 (10.5%) followed by CM Cum 007.2 (9%) and it was minimum (4.9%) in CM Cum 018.1. Virus incidence ranged from 5% to 50%.

Evaluation of pumpkin lines during winter season at hill valley

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2019-20 to find out the suitable pumpkin lines to release as a variety and to utilize in future breeding program of pumpkin. The study was conducted in RCBD with three replications. Seeds were directly sown in the field in unit plot of 2.5 m × 3.0 m on 15 November, 2019. The spacing was 2.0 m × 2.0 m. The land was fertilized with recommended doses of fertilizer following recommended method. Intercultural operations like weeding, irrigation etc. were done as per necessary. Data on yield and yield contributing characters were taken with due time Experimental lines varied significantly for their response to days to 1^{st} flowering (DFF), node order of first female flower (NFF), fruit length (FL), fruit width (FW), flesh thickness (FT), individual fruit weight (IFW), yield and TSS (%).DFF ranged from 65-75, NFF 15-19, FL 10-17, FW 11.7-23.3, FT 2.3-5.0, yield (t/ha) 13-30 and TSS (%) 8.3-14.2. Minimum node order of first female flower (15) was observed in CMRai020. The highest yield (30 t/ha) was found in CMRai0019 followed by CMRai017 (27 t/ha) and the lowest (13 t/ha) was found in CMRai004 and CMRai013 treatment.

Effect of side shoot removal and vine pruning on growth and yield of pumpkin

A study was conducted during 2019-20 at Regional Agricultural Research Station, Jamalpur to investigate effect of side shoot removal and vine pruning on growth and yield of sweet gourd (*Cucurbita moschata* Duch.ex Poir).Seven different treatments *viz.* $T_{1=}$ (Control) no Side shoot pruning, $T_{2=}$Side shoot pruining up to 6^{th}, need $T_{3=}$Side shoot pruning up to9^{th}, node $T_{4=}$Side shoot pruining up to 12^{th}, node $T_{5=}$Maintaining three secondary vines after pruning,$T_{6=}$Maintaining four secondary vines after pruning and $T_{7=}$Maintaining five secondary vines after pruning. The seeds of sweet gourd varieties were sown in poly bags on 20 Oct 2019 and the seedlings were transplanted in the main field on 11th Nov 2019. The experiment was laid out in randomized complete block design with two replications. The unit plot size was 8.0m x 2.5 m maintaining 2.0m x 2.5 m spacing. The land was fertilized with recommended doses of fertilizers following recommended method. The intercultural operations were done as and when needed. Pruning started after first female flower opening in the experiment. Data were recorded from two randomly selected plants per treatment per replication on number of vines/plant, weight of vines/plant (kg), vine length (cm), vine diameter (cm), leaf area (cm^2), internodes length (cm) and vine yield (t/ha). The collected data on different characters were statistically analyzed Character association with fruit and seed yield was done. Results of pruning revealed that T_6 (4-vine) produced the highest fruit yield (fruit yield,12.50 t/ha). However fruit size individual fruit weight and seed quality were better in $T_{6=}$Maintaining four secondary vines after pruning other treatments .On the other hand analysis revealed that pruning had important effects on the yield and quality of fruit and seeds in sweet gourd.

Response of sweet gourd to different irrigation frequency and nitrogen levels

The experiment was conducted for 3 years at the experimental field of Horticulture Research Centre, BARI, Gazipur during 2017-18 to 2019-20 to investigate the response of sweet gourd (cv. BARI Hybrid Misti Kumra-1) under different irrigation and nitrogen levels. The study was carried out in a split plot followed by RCBD with three replications. Three irrigation levels as I_1: Irrigation up to FC at 7 days interval after stand establishment (SE); I_2: Irrigation up to FC at 14 days interval after SE and I_3 : Irrigation up to FC at 21 days interval after SE were considered as main plot treatment and four doses of PU and USG as N_1:100 kg N ha^{-1} as PU; N_2: 100 kg N ha^{-1} as USG; N_3: 80 N ha^{-1} as USG and N_4:60 kg N ha^{-1} as USG were considered as sub-plot treatment. A significant response of sweet gourd to different irrigation and N levels was observed. Among the different treatments combinations, I_2N_3 (irrigation at 14 days interval with 80 kg N as USG) were relatively better yielding (35.08, 36.46 and 34.23 ton ha^{-1}, respectively for the years) followed by I_1N_3 (31.93 ton ha^{-1}), I_2N_2 (34.51 ton ha^{-1}) and I_2N_2 (31.92 ton ha^{-1}), respectively for sweet gourd production. Economic analysis also showed the highest average gross margin (Tk. 288980) and BCR (3.2) with I_2N_3 (Irrigation at 14 days interval with application of 80 kg N ha^{-1} as USG) followed by I_2N_2 (Tk. 222740 with BCR 2.8) and I_3N_3 (Tk. 214950 with BCR 2.7). But higher water productivity (16.52, 11.98 and 19.55 kg m^{-3} water) was obtained with I_3N_3 (Irrigation at 21 days interval with 80 kg N as USG) for three seasons, respectively than I_2N_3. Results revealed that I_2N_3 (irrigation at 14 days interval with 80 kg N as USG) followed by I_2N_2 (Irrigation at 14 days interval with 100 kg N as USG) might be optimum irrigation and fertilizer levels for sweet gourd production on the basis of yield and economic returns. Therefore, although higher water productivity (with I_3N_3), I_2N_3 could be suggested as a good irrigation and nitrogen fertilizer management for hybrid sweet gourd production in respect of yield and economics.

Cucumber

Collection and evaluation of cucumber germplasm

The present study was designed to characterize and evaluate sixteen (16) indigenous cucumber accessions with respect to agro-morphological traits and reaction to different biotic stresses. The experiment was conducted at the experimental field of RARS, BARI, Cumilla during *kharif*-1 season of 2020. All the lines were collected from PGRC (Plant Genetic Resource Centre), BARI (15) and local area of Cumilla (1). At the initial period, six (6) lines were discarded as they did not survive because of pre-emergence wilting. The rest (10) were subjected to data collection and analysis. The unit plot size was 3.0m x 1.5m maintaining 1.5m x 1.5m plant spacing. Twenty five days old seedlings were transplanted in well prepared experimental plot. The recommended dose of fertilizer and agronomic practices were followed to raise a successful crop. There were three replications for taking observations on 10 traits, *viz.* days to first female flowering, fruit length (cm), fruit diameter (cm), fruit weight (gm), cavity breadth (cm), number of fruits/plant, fruit yield/plant (kg) and disease/pest reaction. Disease incidence causing wilt was recorded as number and percentages of survival plants (sixty days after sowing). Screening for virus disease resistance was followed with 0-4 scale (0, no symptoms; 1, 1-25% leaf area with symptoms; 2, 26-50% leaf area with symptoms; 3, 51-75% leaf area with symptoms; 4, 76-100% leaf area with symptoms). All the lines varied significantly regarding all traits under consideration. Besides, the low incidence of virus and wilt diseases, the novel accession CS Cum 001, BD-11659 had good agro-morphological characters with heavy bearing capacity (no. of fruits/plant, 10.5 and 10, respectively) and the highest yield/plant (4.39 kg, 3.29 kg, respectively). CS Cum 001 also had no fruit fly infestation. By the same token, BD-11396 showed resistance to viruses causing curling, mosaic and severe stunting diseases. This accession can be utilized as resistant source to both the diseases. In addition to that, BD-11458 & BD-11382 produced fruits with narrow cavity with good size and shape. Considering all the factors, six (6) accessions i.e. 11659, 11392, 11390, 11377, 11399, 11458, 11382, 11404, 11396 & CS Cum 001 (Nangolkot) were selected for the production of their inbreeds after seed increase.

Regional yield trial of cucumber lines

A regional yield trial with four cucumber (*Cucumis sativa*) lines (*viz*., CS79-3-5-9, CS25-20-10-4-1, CS18-3-5-8 and CS44-5-2-3-6, were evaluated with a local check variety at Olericulture Division, HRC, BARI Gazipur during the *kharif* season of 2019 to study the regional adaptability and yield potentiality. This trial was also conducted to different regional stations of BARI, namely Jamalpur, Narsinghdhi and Hatazari following RCB design with 3 replications. The unit plot size was 7.5 x 1.0 m having single row and 5 plants per plot. The seedlings were transplanted maintaining 1.5 x 1.0 m spacing. The unit plot and blocks both were separated by 60 cm drain respectively. The recommended doses of fertilizer and agronomic practices follow. Data on days to 1st female flower open, node order of 1st female flower open, fruit length (cm), fruit breadth (cm), number of total fruits, individual fruit weight (g), yield/plant (kg), yield (t/ha), virus incidence and fruit fly infestation were recorded from each plants per entry per replication. Analysis of variance (ANOVA) and mean separation of lines were done using Statistix 10 statistical software. The lines varied significantly for their response of different characters studied. The fruits/of tested lines varied from 9.33 to 23.73 and the line CS25-20-10-4-1 showed the highest fruits/plant (23.73). The highest yield per plant (5.25kg) and yield (41.37t/ha) was also observed from CS25-20-10-4-1. The second highest yield/plant (3.87kg) and yield (30.60t/ha) was also observed from CS79-3-5-9. The overall performances of two lines (viz., CS25-20-10-4-1 and CS79-3-5-9) were good. For final conclusion or variety release the trial may be repeated for next one year RYT for confirmation.

Sponge gourd

Evaluation of sponge gourd germplasm

A study was conducted to evaluate sponge gourd (*Luffa cylindrica*) lines in respect of yield and quality at RARS, Jamalpur during the summer season of 2019 due to release a new sponge gourd variety. The experiment was laid out with 3 replications. The plot size was 6.0 m ×1.5m with a planting space of 3m×1.5 m. Each plot contained 2 plants. Twenty five days old seedlings were transplanted in the field on 21 March, 2019. The recommended doses of fertilizer and agronomic practices follow. Data were recorded on days to 1st female flowering, 1st female node order, days to 1st harvest, days to last harvest, fruit length and diameter, number of fruits/plant, fruit yield/plant, fruit yield/plot and per hectare. Data in respect of vegetative, yield and fruit characters were recorded and measured characters were statistically analyzed following a programme Statistical Tools for Agricultural Research (STAR).Nine sponge gourd lines viz. LC Jam-001, LC Jam -002, LC Jam -003, LC Jam -004, LC Jam -005, LC Jam -006, LC Jam -007, LC Jam -008 and LC Jam -009 were evaluated to investigate the yield and yield contributing characters. The higher number of fruits per plant (90.00) was produced by the line LC Jam-006 whereas the lower number of fruits (28.00) was noted from the LC Jam-005. The higher individual fruit weight (141 g) noted in the line LC Jam-008 and lower (98 g) in the line LC Jam-007. The highest fruit yield/plant (12.31 kg) & per hectare (41.04 t) was produced by the line LC Jam-001 and the less 3.16 kg &10.54 t was found by the line LC Jam-005.

Evaluation of sponge gourd hybrids

Five sponge gourd hybrids were evaluated at Olericulture Division, HRC, BARI Gazipur during *kharif* season of 2019. The experiment was laid out in a RCB design with three replications. Seeds of five sponge gourd hybrids were sown on the polybag on 10 April, 2018. Twenty days old seedlings were transplanted in main field on 30 April, 2018. The unit plot size was 10 x 1.0 m having single row and 5 plants per plot. The seedlings were transplanted maintaining 2.0 x 1.0 m spacing. The unit plot and blocks both were separated by 60 cm drain respectively. The recommended doses of fertilizers and application method were followed. Data on days to 1st female flower open, node order of 1st female flower open, fruit length (cm), fruit diameter (cm), duration of harvest, number of marketable fruits, number of non-marketable fruits, number of total fruits, individual fruit weight (g), yield/plant (kg), yield (t/ha) and diseases reaction were recorded from each plants per entry per replication. Analysis of variance (ANOVA) and mean separation of lines were done using Statistix 10 statistical software. Significant variation was found in the studied characters among the hybrids. The hybrid 5 and hybrid 4 required minimum days for 1st male and female flower open (34 and 42 days, respectively). The average fruit weight was also highest in hybrid 3 (261.00g) and the lowest was obtained from hybrid 1(194.00g). The number of fruits per plant was highest in hybrid 3 (282.67) and the lowest was in hybrid 5 (260.00). The highest yield/plant was observed from the hybrid 3 (73.81kg) and lowest yield/plant was observed from the hybrid 1 (51.00 kg). The highest harvest duration was obtained from hybrid 5 (111 days) and lowest harvest duration was in hybrid 3 (103 days). Considering the yield and yield contributing parameters the three hybrids (Hybrid-2, Hybrid-3, and Hybrid-4) performed best. So these three hybrids may be considered for RYT.

Snake gourd

Advanced yield trial of snake gourd lines

An evaluation with thirteen snake gourd (*Trichosanthes cucumerinauar. anguina* L) genotypes, namely; TA01, TA02, TA03, TA04, TA05, TA06, TA07, TA08, TA001,TA002, TA003, TA004, and TA05-3 of snake gourd was conducted at Olericulture Division farm, HRC, BARI, Gazipur during the *kharif* season of 2019 to develop high yielding snake gourd variety. Eighteen days old seedlings were transplanted in the main field on 16 May, 2019. The experiment was laid out in RCB design with three replications. The unit plot size 7.5 m x 1.5m and 6 plants were accommodated in a plot with a plant spacing of 1.2 m apart single plant maintaining a row to row distance of 1.5 m. The recommended doses of fertilizers and application method were followed. The intercultural operations (weeding, irrigation, insecticide spray etc.) were done when necessary. Eleven quantitative characters including days to 1st male flower open, days to 1st female flower open, node order of 1st male flower open, node order of 1st female flower open, fruit length, fruit breadth, fruits/plant, individual fruit weight, yield/plant, yield (t/ha) and harvest duration were measured. Analysis of variance (ANOVA) of genotypes was done through Statstics 10 statistical softwere. Wide ranges of variability were found in the studied characters among the genotypes. The genotypes TA07 required minimum days for 1st male flower (37.00 days) and TA08 required minimum days for 1st female flower (41.00 days) which were significant differences with other genotypes. Maximum number of fruits/plant was found from TA01 (39.50) which was statistically similar with other 11 lines. The yield/plant was ranged from 2.93 to 7.61 kg and yield from 16.41 to 41.83 t/ha. The highest yield/plant and yield (t/ha) was observed from the genotypes TA03 (7.61 kg and 41.83 t/ha, respectively). Considering yield, acceptable fruit size and harvest duration the genotypes TA01, TA02, TA03, TA06 and TA002 were best. So these lines/genotypes may be selected for high yielding snake gourd variety development as well as inbred for crossing of hybridization programme.

Ash gourd

Evaluation of ash gourd lines

The experiment was conducted at the experimental field of HRC, Regional Agricultural Research Station, BARI, Jamalpur during the summer season of 2019 to develop new high yielding OP variety. Five collected ash gourd (*Benincasa hispida*) lines *viz*. BH Jam-001, BH Jam-002, BH Jam-003, BH Jam-004, BH Jam-005 and BARI Chalkumra-1 as check were evaluated. The experiment was laid out in RCB design with three replications. Seeds were sown on 24 February, 2019 and 34 days old seedlings were transplanted in the field at a spacing of 2.0 × 2.5 m. The unit plot size was 10 m × 2.5 m. The recommended doses of fertilizers and method was followed. Selected plants were selfed. Trellis used and irrigation, pruning and other cultural operations were done as and when required. Data on flowering, fruit yield and fruit characteristics were recorded and analyzed statistically using statistical software STAR which was developed by IRRI. The lineBH-Jam-005 took the minimum days (83.30) to 1st harvest followed by BH-Jam-003(83.33), BARI Chalkumra-1(84.00) and BH-Jam-004 (85.33) while the line BH-Jam-002(86.67) took the maximum days. The maximum number of marketable fruits (11.93)/ plant was recorded from BH-Jam-005 followed by the BH Jam-002(10.73) and the minimum number of fruits (5.83) was observed in BH-Jam-004. The highest yield was obtained from BH-Jam-005 (31.67 t/ha) followed by BH Jam-001(29.12 t/ha), while the line BH-Jam-004 produced the lowest yield (14.24 t/ha).

Regional yield trial of ash gourd lines

A regional field trial was conducted with three ash gourd advance lines at Olericulture Division, HRC, BARI, Gazipur during Kharif seasons of 2018-19 to find out suitable ash gourd lines for earliness, highest yield and better quality. The advance lines were BH01, BH02 and BH029 along with BARI Chalkumra-1 as check variety. The experiment was laid out in RCBD with three replications. The unit plot size was 5 m x 6.0 m maintaining 2.0 m x 2.5 m spacing. The recommended doses of fertilizers were used followed recommended method. The intercultural operation was done as and when needed. Data on days to 1st male flower opening, days to 1st female flower opening, node order of 1st male flower opening, node order of 1st female flower opening, days to 1st harvest, fruits number/plant, single fruit weight (g), fruit length (cm), fruit diameter (cm), yield/plant (kg), and yield (ton/ha), fruit shape and fruit color were recorded from five randomly selected plants per entry per replication. The data on different characters were analyzed statistically. Among four advance lines, the days to 1st male, female flower opening and days to 1st harvest were not insignificantly different. Maximum number of fruits/plant was recorded in the lines BH01 (10.96) and BH02 (10.91). In respect of average per fruit weight, BH02 (1.55 kg) produced the heaviest green fruit. The yield/plant was highest in BH02 (16.97 kg) followed by BH01 (15.58 kg. Yield (t/ha) was highest in BH02 (33.94 t/ha) followed by BH01 (31.16 t/ha), which was significantly similar to BARI Chalkumra-1 (27.54 t/ha) and lowest in BH029 (21.68 t/ha). Therefore, two advanced lines viz., BH 01, and BH 02 may be selected for putting into regional yield trial in the following year to confirm the results.

Effect of prilled urea, USG and neem coated urea on the growth, yield and N-use efficiency of broccoli and ash gourd

The experiment was conducted followed by RCBD with three replication during 2018-19 to 2019-20 cropping season. There were 8 treatments as- T_1: Control; T_2: Recommended PU (broadcasted); T_3: Recommended USG (blended); T_4: Recommended Neem coated urea (broadcasted); T_5: Recommended Neem coated urea (blended); T_6: 85% recommended USG (blended); T_7: 85% Recommended Neem coated urea (broadcasted) and T_8: 85% Recommended Neem coated urea (blended). The experiment was conducted on broccoli in winter and Ash gourd in summer season. From two years result for broccoli, and one year results for ash gourd, it was observed that blended USG as well as blended Neem coated urea (NCU) performed better than prilled urea. But in broadcasted condition performance of NCU was not up to the mark. Maximum broccoli yield (18.50 and 31.26 ton ha^{-1}) was obtained from T_6 (85% recommended USG, blended) treatment followed by T_3 (Recommended USG, blended) (18.02 t/ha) and T_8 (85% Recommended Neem coated urea, blended) for the year 2018-19 and 2019-20, respectively. Highest ash gourd yield (101.3 ton ha^{-1}) was obtained in T_5 (Recommended Neem coated urea (blended) followed by T_8 (Recommended Neem coated urea, blended) treatment (100.8 ton ha^{-1}). Results showed for both the crops that USG as well as Neem coated urea performed better as compared to prilled urea and maximum economic benefit was obtained with urea super granule. But performance of NCU under broadcasted condition was not satisfactory.

Teasle gourd

Diversity of teasle gourd

The trial was conducted using twenty nine teasle gourd genotypes at Olericulture Division, HRC, BARI Gazipur during summer 2019 to study the diversity of teasle gourd from the crossing populations as its diversity are narrow in Bangladesh (two color-green and yellow were common as teasle gourd are vegetatively propagated) focusing seed number and hardness are concern of the consumers. In order to create variation within the collected genotypes through crossing and plants were evaluated grown from seeds. Diversity of teasle gourd was observed in the crossed population of 7 main parents, in the plants characters, male female ratio, fruit size, shape, color. The number of fruits, single fruits weight and yield per plant were also varied significantly. Number of fruits/plant (NOFPP) were recorded the highest in MD-0019-5 (277) while the lowest in MD-0022-11 (7). A inconsistent result was observed with in the same accession of original lines. The heaviest fruits were observed in the genotypes MD-0021-12 (107 g) followed by MD-0021-9, MD-0013-3-4, MD-001, MD-009-3-5 while the lightest was observed in MD-0022-1(53.6 g). All the genotypes produced oval shape fruits with green, greenish yellow, and yellowish green. seed is the major constraints of teasle gourd thereby number of seed considered as important parameter for selecting lines further improvement. Maturity was determined where 10-12 days after anthesis was found optimum to consume. As the accessions were produced from seed crossed at different lines therefore, different types of plants were produced and male female was one of them. The maximum number of females was recorded at MD 13 (60%) while the lowest percent were observed at MD 0020. The maximum amount of suckers were observed at MD 0022 genotypes, where maximum seeds were recorded at MD 0022-1.

Evaluation of teasle gourd lines in summer at Jamalpur region

A study was conducted to evaluate teasle gourd (*Momordica dioica*) lines in respect of yield and quality at HRC field, RARS, Jamalpur during the summer season of 2019 to release a new teasle gourd variety. Five teasle gourd lines *viz*. MD Jam-001, MD Jam -002, MD Jam -003, MD Jam -004 and Md Jam -005were evaluated to investigate the yield and yield contributing characters. The experiment was laid out in RCBD with 3 replications. The plot size was 10.0 m ×2.0 m with a planting space of 2.0m ×2.0 m. Each plot contained 5 plants. Seedlings were transplanted in the field on 09April, 2019. The recommended doses of fertilizers and agronomic practices were followed. Data were recorded on days to 1st female flowering, 1st female node order, days to 1st harvest, days to last harvest, fruit length and diameter, number of fruits/plant, fruit yield/plant, fruit yield per plot and per hectare. Data in respect of vegetative, yield and fruit characters were recorded and measured characters were statistically analyzed. The higher number of fruits per plant (116.00) was produced by the line MD Jam-001 whereas the lower number of fruits (78.00) was noted from the MD Jam-005. The higher individual fruit weight (56 g) was noted in the line MD Jam-003 and lower (43 g) in the line MD Jam-004. The maximum fruit yield/plant (6.15 kg) & per hectare (15.37 t) was produced by the line MD Jam-001 and the minimize 3.74 kg &9.34 t was found by the line MD Jam-005.

Advanced yield trial of teasle gourd lines

The study was carried out at the experimental field of Olericulture Division, HRC, BARI, Gazipur, Bangladesh to evaluate the teasle gourd germplasms for variety development and future breeding program. Eleven genotypes, namely MD 0021 MD 0022, MD-015-2, MD-012-2, MD-006-2, MD-013-2, MD-009-3, MD 0020, MD 0019, MD-014-2 and MD-008-1 were evaluated during the summer season of 2019. Healthy and disease free rhizomes of teasle gourd were planted in 25 February, 2019 at a spacing of 1.5 m x 2 m. The unit plot size was 2.5 m x 2.5 m. The field was fertilized with cowdung-N-P-K-S@ 5 ton-20-08-14-6 kg/ha. Different morphological and yield attributing characters were recorded from three randomly selected plants from each treatment. The line MD-006-2 took the longest days (115) and MD 0019 took the shortest days (106) to harvest. The highest number (203.00) of fruits/ plant, heaviest fruit (80.33 g) and highest fruit wt./ plant was recorded from MD 0021(16.17 kg). The longest fruit was observed in MD-006-2 (9.13cm) while the shortest was MD-008-1 (6.43cm).The line MD 0022 (4.43cm) produced the widest fruit while MD-009-3 (3.57cm) produced the wides fruit. In case of inner flesh thickness it was found that the line MD 0022 produced the highest flesh thickness (0.64cm) and the lowest (0.32cm) was recorded from MD 0020. The highest yield(40.43t/ha) was obtained from the line MD 0021 and the lowest was recorded from MD-006-2. In case of fruit color, most of the lines produced green color fruit except MD-013-2 and MD-006-2, which produced yellow orange colored fruit. Considering the yield contributing characters, color and size the lines MD 0020, MD 0021, MD 0022 and MD-015-2 may be selected for RYT.

Effect of micronutrient application and rhizobium inoculation on productivity and quality of garden pea

An experiment was carried out in the research field of HRC, BARI, Gazipur during Rabi season of 2019-20 to estimate the suitable combination of Zn, B and Mo with Rhizobium for nodulation, quality and yield maximization of garden pea (*Pisum sativum*).The experiment was planned with six treatments *viz*., T_1 = Control, T_2= Rhizobium inoculation, T_3= Zn_3Mo_1+ Rhizobium, T_4= B_2Mo_1+ Rhizobium, T_5= Zn_3B_2+ Rhizobium, T_6= $Zn_3B_2Mo_1$+ Rhizobium and T_7= $Zn_3B_2Mo_1$ along with the blanket dose of $N_{40}K_{50}P_{24}S_{10}$ kg ha^{-1} and cowdung 5 t 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 5118 to 7915 kg

ha^{-1}across the treatments. The seeds yield varied from 1284 to 1718 kg ha^{-1}among the treatments. The significantly highest green pod (7915 kg ha^{-1}) and seed yield (1718 kg ha^{-1}) was found in T_6treatment and the lowest were found in control plot. The maximum nodulation (25.4) and protein content (23.1%) were found in T_6 treatment. The greatest gross return was counted from the treatment T_6.Considering the yield, quality and economics, the combined application of Zn 3 kg ha^{-1},B 2 kg ha^{-1} and Mo 1 kg ha^{-1} with Rhizobium 50 g kg^{-1} seed can be recommended for garden pea cultivation.

Pointed gourd

Regional yield trial of pointed gourd hybrids

An experiment was carried out at Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2018-19 to evaluate the performance of five promising hybrid pointed gourd lines regarding yield and desirable characters. The highest number of fruits/plant (154) was produced by the line PG009xM_2 and the lowest (103) in PG018xM_2. The highest yield (52.59 t/ha) was obtained from PG009xM_2 and the lowest yield (35.14 t/ha) was obtained from PG008xM_1. Considering yield, fruit quality and number of seeds the line PG009xM_2 was found promising and can be release as a variety.

Squash

Advanced yield trial of squash lines

Five squash lines with the check variety BARI Squash-1 were evaluated at the experimental field of Olericulture Division, HRC, BARI, Gazipur during the winter season of 2019-20 to select the high yield potential and attractive shape squash lines. The lines CP002, CP004, CP006, CP007 and CP007-2 were used in this study. The seeds were sown in poly bag and 21 days old seedlings were transplanted in the main field on 4 December, 2019. The unit plot size was 1.2 x3 m maintaining 1 m plant spacing. The land was fertilized with cowdung-N-P-K-S-Zn-B @ 10 ton -80-35-75-18-4.3-1.70 kg/ha respectively. Entire cowdung, P, S, Zn, B and 1/3rd of K were applied during pit preparation. Entire amount of N and rest amount of K were applied in 3 equal splits (15, 30 and 45 days after transplanting). Weeding, irrigation and other intercultural operations were done as and when necessary. During the cropping period the whole plot was covered by nylon net to protect from mite infestation. Data on different parameters such as days to first female flower open (DFF), node order to first female flower (NFF), fruit length (FL), Fruit breadth (FB), flesh thickness (Fl. thickness), average fruit weight (Av. FWt.), fruits/plant, yield/plant, yield (t/ha), TSS(%) and fruit shape were recorded and analyzed statistically. Significant variation was observed among the squash lines for different characters. The highest average fruit weight was observed from BARI Squash -1 (2.32 kg) which was used as check and lowest fruit weight was found in the line CP007 (1.15 kg). From the evaluated lines the check variety BARI Squash-1 was superior for its individual fruit weight and yield/plant. Next to BARI Squash -1 two lines CP007 and CP007-2 were good for its attractive shape, size and yield potential. In this respect, two lines CP007 and CP007-2 may be recommended for RYT.

Water melon

Regional yield trial of water melon lines

A regional field trials was conducted in the research field of Olericulture Division, HRC, BARI, Gazipur during winter seasons 2019-20 to evaluate the performance of advance watermelon lines (S-4/07,S-4/08, S-5/144, CLPK-18) with Sweet Black-2 as a check variety. The experiment was laid out in RCBD design with three replications. The seeds were sown in January 28, 2020 and planting was done in February 24, 2020. The unit plot size was 5 m x 6.0 m maintaining 2.0 m x 2.5 m spacing. The land was fertilized with recommended doses of fertilizers following recommened method. The intercultural operation was done as and when needed. Pest attacks were prevented by spraying of chemical pesticides. Data on days to 1st male flower opening, days to 1st female flower opening, node order of 1st male flower opening, node order of 1st female flower opening, days to 1st harvest, fruits number/plant, single fruit weight (g), fruit length (cm), fruit diameter (cm), yield/plant (kg), and yield (ton/ha), fruit shape and fruit color were recorded from five randomly selected plants per entry per replication. The data on different characters were analyzed statistically Among five advance lines average fruit weight was higher in S-5/144 (8.42kg) followed by S-4/8 (5.98kg). Significantly long type fruit was found in S-4/8 (43.08cm) and roundish fruit was in S-5/144 (60.32 cm). The yield/plant differed significantly among the lines. It was highest in S-5/144 (22.21 kg) followed by S-4/7 (21.73 kg), S-4/8 (17.74 kg), lowest in Sweet black-2 (10.30 kg) and CLPK-18 (7.50 kg). Therefore, three advanced lines *viz*. S-5/144, S-4/7 and S-4/8 lines may be selected for regional yield trial in the following year to confirm the result.

Evaluation of collected exotic commercial watermelon germplasm

A field experiment was conducted on watermelon at Regional Horticulture Research Station, BARI, Shibpur, Narsingdi during February 2020 to May 2020 to evaluate the performance of four commercial watermelon varieties, namely Big Family, More 039, Big boss and Champion) with a view to recommending the best variety that will be used to make diverged genotypes and to develop inbred lines. Seeds were sown on 14 February, 2020. Each plot measured 2m x 2m separated by 1 m each between plots and between replicates. The experiment was arranged in a randomized complete block design and replicated three times. Pest attacks were prevented by spraying of chemical pesticides and weeding was done as and when due before harvesting. Data collected, and analyzed following software R The result showed that individual fruit weight, fruit weight per plant and yield (t/ha) were highest in Big family. Based on the performance, Big Family may be selected to develop inbred lines.

Netted melon

Evaluation of advanced netted melon lines

The study was conducted with hundred netted melon plants at the research field of Olericulture Division, HRC, BARI, Gazipur during 2019-2020 with a view to developing a variety of netted melon. Last year CMR-12-2-91 was selected from F_2 population and CMR-1-37-46-11, CMR-1-37-46-12 and CMR-1-37-46-15 from F_4 population. This study was conducted with 25 plants for CMR-12-2-91 to develop F_3 generation and 75 plants for CMR-1-37-46-11, CMR-1-37-46-12 and CMR-1-37-46-15 to develop F_4 generation. To developed F_3 and F_4 generation seeds of previous selected generation were sown on 13 September, 2019 to develope a variety of netted melon considering higher TSS, intensity of net and flesh color. Twenty five days old seedlings were transplanted in the net house on 13 October, 2019. The non-replicated evaluation trial was laid out maintaining 50 cm line to line and 40 cm plant to plant spacing. The recommended doses of fertilizers and agronomic practices were followed. Data on different parameters such days required for net development of fruit (day), fruit weight (g), fruit length (cm), fruit breadth (cm), fruit cavity(cm^2), pericarp thickness (cm), TSS (%) were recorded and statistically analyzed. Among F_3 plants ranges of individual fruit weight 600-2400 g whereas it was 480-1400 g for F_4 generation. Based on TSS all the plants categorized in 3 groups. There was no plants below 5% of TSS in both generation, 09 plants showed 5-8% of TSS, in both generation and 01 and 06 plants showed more than 8% of TSS respectively. On the basis of individual fruit weight, there was no plants produced less than 600 g individual fruit weight, 03 plants produced 600-1000 g and 07 plants produced more than 1000g for F3 generation whereas it was 01, 07 and 06 for F4 population. In case of pigmentation, 08 plants showed white and 02 were green for F_3 population and 15 plants for F_4 showed green. Six plants showed light netting, 01 plant showed medium netting and 03 plants dense netting for F_3 generation where as it was 03,0,12 respectively for F_4 generatioon. On the basis of fruit flesh color, all plants of F_3 population showed orange colour. In case of F_4 population 06 plants showed green and 09 plants showed orange. From the study it may be concluded that on the basis of qualitative and quantitative characters five plants CMR-12-2-91-10, CMR-1-37-46-11-12, CMR-1-37-46-11-45, CMR-1-37-46-12-45 and CMR-1-37-46-12-50 were selected for AYT.

Muskmelon

Collection and evaluation of muskmelon germplasm

The present study was undertaken with 44 germplasm of muskmelon (Cucumis melo L.) which were collected from PGRC, BARI (40) and local area of Cumilla (4) and evaluated at RARS, Cumilla during summer, 2020 for screening suitable lines having high yield potentiality and quality. The plot size was 4.5m×1m and plant spacing was 1.5 m×1m. Plot to plot drain was 60 cm. It was a non-replicated trial. Weeding, irrigation and other intercultural operations were done as and when necessary. The transplanted seedlings were always kept under careful observation. Data were collected on days to first female flower, fruit length, fruit breadth, average fruit weight, fruit yield/plant, no. of fruit/plant, cavity diameter (cm), fruit yield /plot, yield (t/ha), TSS%. The germplasm MCM Cum-003 showed early female flowering (55 days) compared to others. The longest fruit was observed in BD-2319 (26.3 cm) whereas the shortest was found in MCM Cum-005 (12.6 cm). The maximum fruit breadth was obtained in MCM Cum-003 (14.6 cm) whereas the minimum in BD-2261 (9.8 cm). The highest individual fruit weight was found in MCM Cum-003 (1639 g) which was followed by BD-2319 (1528 g) whereas the lowest was found in BD-2262 (583g). No. of fruit/plant was maximum in BD-2257 (11) and minimum in MCM Cum-001(4.00). The highest yield (t/ha) was observed in BD-2276 (61.51) followed by BD-2257 (55.79) while the lowest yield was found in BD-2262 (21.75). Maximum TSS (5.5%) was obtained in BD-2295, BD-2162 and BD-2310. However, total sixteen (16) germplasm out of forty four (44) were selected for the next year evaluation with replicated trial after seed increase.

Evaluation of year round muskmelon lines at hill valley of Chattogram hill tracts

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2019-20 to find out the suitable muskmelon germplasm for is year round potential to release as a variety and to utilize in future breeding program of muskmelon. It was conducted in RCBD with three replications. Seeds were directly sown in unit plot of 1.5 m. x 1.5 m on 10 November, 2019. The land was fertilized with well decomposed cowdung @ 10 t/ha cowdung, 78 kg N, 35 kg P, 75 kg K, 18 kg S, 4.2 kg Zn and 0.34 kg B per hectare. Entire cowdung, P, S, Zn, B and 1/3 of K were applied during pit preparation which was 7 days before seed sowing. N @ 50 kg/ha was applied at the day of transplanting. Rest of K @ 50kg /ha was applied twice after transplanting at 20 days interval and N was applied in 4 equal installments at 15, 30, 55 and 75 days after transplanting. Intercultural operations like weeding, irrigation etc. were done as per necessary. Data on yield and yield contributing characters were taken and analyzed. Germplasm were varied significantly for their response to days to 1st female flowering (DFF), node order of first female flower (NFF), fruits/plant (FPP), fruit length (FL), fruit girth (FG), flesh thickness (FT), average fruit weight (AFW), yield/plot and TSS (%). DFF ranged from 27.0 to 34.3, NFF 6.7-10.7, FPP 7.3-2.5, FL 24.4-47.2, FG 10.7-17.9, FT 2.20-2.52, AFW (gm) 1700-6700, yield/plot (kg/2.25 m^2) 6.0-20.8, yield (t/ha) 26.5-92.2 and TSS (%) ranged from 2 to 4.7. Minimum node order of first female flower (6.7) was observed in CMRai004. The highest yield (92.2 t/ha) was found in CMRai017 followed by CMRai008 (70.7 t/ha) and the lowest (26.5 t/ha) was found in CMRai016.

Hyacinth bean

Collection and evaluation of hyacinth bean lines at Chattogram region

The experiment was conducted at Agricultural Research station (ARS), Pahartali, Khulshi, Chattogram during *rabi* season of 2019-20. There were 31 genotypes used as materials to evaluate yield potentials. The earliest flowering (33 DAS) was recorded from LP Pah038 and the longest duration (71 DAS) was recorded from LP Pah020. Maximum no. of pods/panicle (15) was produced from LP Pah037and minimum (07) was from LP Pah003, LP Pah007, LP Pah011, LP Pah016 and LP Pah023. The highest pod weight (16.0 g) was obtained from LP Pah019 and the lowest (6.1 g) was from LP Pah026. Maximum number of seeds/pod (5.75) was produced by LP Pah020 and minimum

(3.6) was produced by LP Pah026. The highest hundred fresh seed weight (140 g) was recorded from LP Pah011 and the lowest (60 g) was from LP Pah026. LP Pah037 gave the highest yield/plant (2040g) followed by LP Pah035 (1560g) and LP Pah023 gave the lowest yield/plant (588 g). Twelve genotypes, three genotypes, seven genotypes, two genotypes belong to green, greenish red, brownish green surrounded by brown and red colored pod, respectively. Rest of the genotypes shown light yellow, light green surrounded by brown, greenish brown, grey brown surrounded by brown, reddish green and Green surrounded by brown colored pod. Eighteen genotypes have got brown colored stem and thirteen genotypes belong to green colored stem. Seventeen genotypes appeared pink colored flower, twelve genotypes shown white colored flower and one genotype belongs to white surrounded by light green colored flower.

Preliminary yield trial of hyacinth bean lines

The study was conducted at the Olericulture Division, HRC, BARI, Joydebpur, Gazipur during winter season of 2019-20 to evaluate six selected superior lines of country bean including DL (St)-002, DL (St)-004, DL (St)-008, DL (St)-024, DL (St)-025, DL (St)-032 and BARI Shim-1 as check variety. The lines varied significantly for their response to all the characters studied. The line DL (St)-024 required minimum days (43) for flowering. The earliest (58 days) harvest was done in DL (St)-004. The line DL (St)-002 produced the maximum number of pods/plant (336). The single pod weight was the highest in DL (St)-032 (24.43 g) which also produced the longest (17.23 cm) and the widest (4.36 cm) pods. The highest pod yield per plant was recorded from DL (St)-002 (4.24 kg), followed by BARI Shim-1 (3.93 kg) whereas the lowest yield from DL (St)-008 (1.74 kg). Highly mosaic virus infestation was observed this year in all the lines and also in check variety. Based on yield and qualitative parameters the genotypes DL (St)-002, DL (St)-024, and DL (St)-032 were found promising. The experiment may be put into advanced yield trial in the following year.

Advanced yield trial of selected hyacinth bean lines

An experiment was conducted at the HRC field, Regional Agricultural Research Station (RARS), Jamalpur during 2019-2020 to observe the performance of yield and yield contributing characters of hyacinth bean lines. There were six hyacinth bean germplasm *viz*. CB Jam-001, CB Jam-002, CB Jam-003, CB Jam-004, CB Jam-005 and CB Jam-006 with BARI Shim-1 & BARI Shim-6 as check were used and fifteen days old seedlings were transplanted in the main field on 22 September 2019. The experiment was laid out in a Randomized Complete Block Design with three replications. The size of a unit plot was 6.0 m x 1.5m with plant spacing of 1.5 m x 1.5 m. Each plot contains 4 plants.. Maximum number of pod/plant (773) was observed from CB Jam-001 and minimum (310) from CB Jam-005. CB Jam-005 gained maximum individual pod weight (21 g) whereas minimum observed in CB Jam-003 (7.60 g). Maximum pod yield/plant (11.17 Kg), per plot (44.70Kg) and per hectare (37.25 t) harvested from CB Jam-006 and minimum pod yield per plant (4.36 Kg), per plot (17.41Kg) and per hectare (14.51 t) obtained from CB Jam-003. The promising lines may be proposed for putting into regional yield trial at different AEZs of Bangladesh.

Effect of supporting system on growth and yield of hyacinth bean var. BARI Sheem-8

The experiment was conducted at Agricultural Research Station, Pahartali, Khulshi, Chattogram during *rabi* season of 2019-20. There were six treatments *viz*. i. Bamboo trail at 1m spacing, ii. Bamboo frame with net at 1m spacing, iii. Bamboo stick at 45 cm spacing, iv. Bamboo stick at 60 cm spacing, v. Bamboo stick at 75 cm spacing and vi. Top of bamboo canopy at 1m spacing considered. The experiment was laid out in a Randomized Complete Block Design with three replications. The unit plot size was 3m x 3m. Intercultural operations were done as and where necessary. The highest number of pod plant-1 (75) was found from bamboo stick at 45 cm spacing followed by bamboo trail and bamboo frame with net (68.33) and the lowest was found from top of bamboo canopy (54.67). The highest individual pod weight (12.63g) was observed on bamboo stick at 75 cm spacing followed by bamboo frame with net (12.33g) and the lowest was top of bamboo canopy (11.57g). Maximum yield was obtained from top of bamboo canopy(19.59 t ha-1) followed by bamboo stick at 60 cm spacing (13.23 t ha-1) and minimum was from top of bamboo canopy (6.92 t ha-1) followed by bamboo trail (7.81 t ha-1). Bamboo stick at 45 cm spacing produced the highest number of pods plant-1 (75), yield plant^{-1} (880g) and yield (19.59 t/ha) and top of bamboo canopy produced the lowest number of pod plant-1 (54.67), yield plant^{-1} (634g) and yield (6.92 t/ha).

Effect of plant growth regulators on the performance of summer country bean

A field experiment on summer country been taking the variety 'BARI Shim -7' was conducted at the Plant Physiology Field of Horticulture Research Center, Bangladesh Agricultural research Institute, Gazipur during the summer seasons of 2017, 2018 and 2019 to study the effect of plant growth regulators on growth and yield of the crop. The experiment was conducted in RCBD with three replications. The experiment consisted of ten treatments *viz*., four NAA concentrations (15, 30, 45 and 60 ppm), three CCC concentrations (200, 300 and 400 ppm), two GA_3 concentrations (20 and 30 ppm) and tap water as control. All growth regulators performed well in respect of all characters studied over control. Among all foliar agents, the response of NAA was found better. Pooled data of three years revealed that stem girth, vine length, plant dry weight, SPAD value, number of pods/cluster, pod length, individual pod weight, number of pods/plant and %pod set were found maximum from NAA 60 ppm followed by NAA 45 ppm. Maximum pod yield/plant was obtained from the application of NAA 60 ppm (1943.97 g/plant) followed by NAA 45 ppm (1874.47 g/plant). Average of three years' result indicated that the highest pod yield per hectare (10.19 t/ha) was recorded with the application of NAA 60 ppm. Application of NAA 60 ppm gave the maximum net return338.15 thousand Tk. and BCR of 2.97. NAA 60 ppm can be recommended for cultivation of 'BARI Shim-7' in summer season.

Screening country bean germplasm for resistance to bean yellow mosaic virus disease

The experiment was conducted in Horticulture research field, BARI, Gazipur during winter 2019-20 cropping season with some promising varieties and lines of country bean to find out resistant sources against country bean yellow mosaic virus (YMV) disease. A total of 22 country bean varieties/ lines were evaluated including susceptible check. No lines have been performed as immune or resistance to the mosaic virus disease. However, eight lines showed moderately resistant resistant and rest of the lines were susceptible to highly susceptible to disease. BD-10522 germplasm produced the highest yield (17.67 to/ha) with 8.33% disease incidence followed by BD-10513 (15.11 ton/ha), BD-10508 (15.22 ton/ha) and BARI Sheem-1 (15 ton/ha) with disease incidence 8.33%, 25%, 83.33% and 33.33%, respectively. This is first time of the evaluation, therefore further trial necessary for confirmation the results.

On farm validation of biorational integrated pest management (IPM) packages for quality and safe country bean production

The experiment was carried out at farmer's field of Two Upazillas of Mymensingh district (Sadar and Nandail), two upazillas of Netrakona District (Durgapur & Kalmakanda) and Two Upazillas of Sherpur district (Nalitabari and Nakla)duringJuly 2019 to March 2020. BARI Seem-1was used as test crop. Total five IPM packages *viz*, Package1= Hand picking and destruction of infested flower/pods and shoot at 5 days interval + Installation of yellow sticky trap and sex pheromone trap + spraying of Azadirachtin (Phytomax) at weekly interval commencing from the first incidence, Package2= Hand picking and destruction of infested flower/pods and shoot at 5 days interval + Installation of yellow sticky trap and sex pheromone trap + Alternate spraying of Azadirachtin (Phytomax) and Anterio @ 1g/L of water at weekly interval, Package3= Hand picking and destruction of infested flower/pods and shoot at 5 days interval + Installation of yellow sticky trap and sex pheromone trap + Alternate spraying of soap water @ 5g/L of water and Spinosad (Success 2.5SC) @1.25ml/L of water at weekly interval commencing from the first incidence, Package4= (Farmers' practice): Spraying of Emamectin benzoate (Proclaim 5SG)+ Spraying of Clorantraniliprole (Coragen) and Package 5= Untreated control, were evaluated against major insect pests of country bean following RCB design with ten replications. Results revealed that P_2 package (Hand picking and destruction of infested flower/pods and shoot at 5 days interval + Installation of yellow sticky trap and sex pheromone trap + Alternate spraying of Azadirachtin (Phytomax) and Anterio @ 1g/L of water at weekly interval) treated plots showed the best performance considering reduction of insect pest infestation, increase of marketable yield and marginal benefit cost ratio.

Garden pea

Evaluation of garden pea germplasm

An evaluation of garden pea germplasm was conducted at Olericulture Division, Joydebpur, Gazipur during 2019-20 to develop bold seeded garden pea variety with high yield potentiality. In a non-replicated trial twenty four garden pea germplasm were evaluated along with with BARI Motorsuti -1, BARI Motorsuti -2 and BARI Motorsuti -3 were use as check. Seeds of all treatment were sown in November 28, 2019. The highest number of pods/plant (64) was recorded in GP -15. Number of pods was also higher in GP-23 and GP -51 (46) followed by GP-17 and GP-20 (44). Single pod weight was maximum in BARI Motorshuti-2 (5.51 g) followed by BARI Motorshuti-1 (4.87 g), BARI Motorshuti-3 (4.12 g) and GP-13 (3.66 g). Significantly highest pod yield/ha were obtained from BARI Motorshuti-1 (15.08 t/ha) and GP-31 (12.86 t/ha) followed by BARI Motorshuti-2 (11.97 t/ha), GP-52 (11.05 t/ha) and GP-01 (9.38 t/ha). Beside this, another eight lines viz., GP-13, GP-15, GP-23, GP-24, GP-32, GP-33, GP-35, GP-51 produced 7.62 to 8.35 t/ha which was parallel to the yield of BARI Motorshuti-3 (8.06 t/ha). So, considering bold seed as well as similar pod yielder like BARI Motorsuti-01, BARI Motorsuti - 03 ten (10) lines *viz*., GP-31, GP-52, GP-13, GP-15, GP-23, GP-24, GP-32, GP-33, GP-35, GP-51 may select for preliminary yield trail next year.

Effect of different sowing dates on growth and yield of garden pea at Moulvibazar

A trial on effect of sowing dates on growth and yield of garden pea was conducted at RARS, Akbarpur, Moulvibazar, during *rabi* season of 2019-20. Five different sowing dates *viz*., (D_0: 16 October, D_1: 1st November, D_2:16th November, D_3:1st December, D_4:16th December) were taken under the study to estimate response to growth and yield attributes of garden pea. Days to flowering varied from 34 to 44. The days to maturity ranged from 55 to 65. The maximum days to mature (65) were recorded in D_4 treatment and the minimum days to maturity (55) was recorded in D_1 treatment. The plant height ranged from 48.83 to 54.53cm. The highest plant height (54.53 cm) was recorded in D_3 treatment and the lowest plant height (48.83 cm) was recorded in D_1 treatment. The number of branches varied from 3.33 to 6.67. The maximum number of branches/plant (6.67) was recorded in D_3= Dec and the minimum number of branches per plant (3.33) was recorded in D_4. The number of pods per plant ranged from 5.67 to 10.33. The maximum number of pods per plant (10.33) was recorded in D_3 and the minimum number of pods/plant (5.67) was recorded in D_4 treatment. The pod length varied from 6.50 to 7.13. The number of seeds/pod varied from 5.47 to 8.13. The maximum number of seeds per pod (8.13) was recorded in D3 treatment. The minimum number of seeds/pod (5.47) was recorded in D4 treatment. The 100 seeds weight ranged from 43.90 to 57.33g. The highest weight of 100 green seeds (57.33g) was recorded in D_3 treatment followed by (52.80g) in D_2 treatment and the lowest (43.90 g) was recorded in D_4 treatment. The seed yield (kg/ha) varied from 1138.7 to 3475. The highest seed yield (3475kg/ha) was recorded in D_3 and the lowest seed yield (1138.7 kg/ha) was recorded in D_4. The disease reaction of different treatments varied from 1-3. The D_3: (1st December), sowing showed better results, produced the highest (3475 kg/ha) green seed yields and showed low disease reaction at Moulvibazar region of Bangladesh.

French bean

Evaluation of newly collected french bean germplasm

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during the season of 2019-20 to find out the suitable French bean lines to release as a variety. There were five French bean entries used as materials, while BARI Jharsheem-2 was used as check variety. Seeds were sown on 20th November, 2019@ two seeds/ hill. After 15 days after sowing thinning was done from each hill keeping one healthy seedling. Experimental lines varied significantly for their response to plant height (PH), 50% flowering (50F), Pod length (PL), Width of Pod (PW), No. of green pod per plant (GP), individual pod weight (IPW), Pod yield/plot(kg), pod yield/hector (ton)(PY), Seed yield/plot(kg) and seed yield per hector(ton)(SY). Of these, 50F ranged from 33-40, PH 46.7-268.3, PL 11.8-19.1, PW 0.7-1.7, GP 1214-1908, IPW5.2-8, PY(t) 8,96-12.2 and SY(t) 5.6-10.0. The highest seed yield (10 t/ha) was found in PVRai001 followed by PVRai004 (7.5 t/ha) and the lowest (5.6 t/ha) was found in PVRai005. Among the germplasm PVRai001, PVRai003 and PVRai004 were found promising.

Okra

Collection and evaluation of okra germplasm

This experiment was conducted during *kharif* 2019 in the experimental field of RARS, Cumilla. A total of 13 germplasm of okra were collected from different locations of Cumilla region to evaluate yield and tolerance to YVMV. The experiment was laid out in Randomized Complete Block Design with three replications. Results revealed that maximum plant height was observed in AE Cum-009 (193.40 cm) followed by AE Cum-012 (191.00 cm). The longest fruit was observed in AE Cum-002 (15.50 cm) and BARI Dherosh-2 (15.50 cm) and the shortest was observed in AE Cum-003 (12.00 cm) and AE Cum-013 (12.00 cm). The widest fruit was found from AE Cum-008 (2.32 cm) followed by AE Cum-010 (2.12 cm) and BARI Dherosh-2 (2.12 cm). Number of fruits/plant was also varied among the okra germplasm. The maximum fruit/plant was produced by BARI Dherosh-2 (31.67) followed by AE Cum-009 (27.23) and minimum was produced by AE Cum-007 and AE Cum-008 (10.0). Individual fruit weight was highest in AE Cum-008 (24.05 g) followed by AE Cum-005 (21.90 g) and it was the lowest in AE Cum-011 (12.26 g). Fruit yield also varied significantly and it ranged from 8.90 to 25.29. AE Cum-009 produced highest yield (25.29 t/ha) followed by BARI Dherosh-2 (22.23 t/ha) and the lowest was produced by AE Cum-011 (8.90 t/ha). Among the thirteen germplasm, AE Cum-005 (2.0%) and AE Cum-009 (5.5%) showed minimum YVMV infestation and others were susceptible to YVMV. So the line Cum-005 and Cum-009 may be selected for advanced yield trial (RYT).

Regional yield trial of selected okra lines

A field experiment was carried out at Regional Agricultural Research Station, Ishwardi during kharif season of 2019 to study the yield and over all performance of okra lines. Four okra lines *viz*. AE 018, AE 86, AE 87 and AE 122 with a check BARI Dheros-2 were evaluated in this study. The experiment was laid out in RCB design with three replications. The highest number of fruits/plant (30) was recorded in AE 122 and AE 86 whereas; the lowest number of fruits/plant (22) was recorded from AE 018. The highest yield (24.87 t/ha) was obtained from AE 122 and the lowest (14.40 t/ha) was in AE 87.

Regional yield trial of selected okra lines

The experiment was conducted with four okra (*Abelmoschus esculentus* L. Moench.) lines *viz*. AE-018, AE-086, AE-087, AE-122 along with BARI Dherosh-2 as check at the field of Olericulture Division, HRC, Gazipur, Regional Agricultural Research Station, Ishwardi and Jamalpur during the summer season of 2019 to evaluate the lines for yield performance. Plant height at last harvest was varied from 150.53 to 161.60 cm. The tallest plant was found from BARI Derosh-2 (161.60 cm) and the shortest from AE 086 (150.53 cm). The highest fruit yield was found from BARI Derosh-2 (1.19 kg) followed by AE 122 (1.07 kg). Number of fruits/plant ranged from 36.47 to 41.60. The highest number of fruit/plant was found from BARI Derosh-2 (41.60) followed by AE-122 (36.47). Fruit yield/hectare varied significantly and ranged from 40.57 to 51.40 ton. The highest fruit yield per hectare was found from BARI Derosh-2 (51.40 ton) followed by AE 122 (48.53 ton).

Effect of sowing time on the growth and yield of BARI Dherosh-2

An experiment was conducted at Regional Agricultural Research Station, Jamalpur during 2019 to study the effect of sowing time on the growth and yield of BARI Dherosh-2. Seeds were sown on 1st week of every month of the year to observe the performance of year round production and diseases reaction especially to YVMV of BARI Dherosh-2. Less or no yield was found in November, December, January and February sowing due to failure of germination under low temperature. But it was recovered under poly tunnel okra sowing. It was observed that optimum time of cultivation of BARI Dherosh-2 was March, April and May. On the other hand, low yield was observed in the month of June, July, August, September and October sowing due to high YVMV severity (70-90%). But it was recovered under mesh net okra sowing. Number of fruits per plant varied from 15 to 36 where the maximum in April sowing and minimum in August. Maximum individual fruit weight (18 g) was found from April sowing and the lowest (12 g) from December and January sowing. Maximum yield/plant (645 g) and yield/ha (32 t) was found from April sowing and minimum yield per plant (250 g) and yield per hectare (12.4 t) was found from August sowing. It was observed that optimum time of cultivation of BARI Dherosh-2 was March, April and May. In this time severity of insect and diseases were low and high yield was found

Carrot

Advanced yield trial of carrot lines

A field trial was conducted at the experimental field of Olericulture Division, HRC, BARI, Gazipur during the winter season of 2019-20 to evaluate the performance of nine carrot lines selected from 16 germplasm which were collected locally from different sources in 2018-19. The objective was to select the superior lines having seed production potentiality. The maximum marketable root yield was recorded from DC-0031 (16.70 t/ha), DC-0032 (15.90 t/ha) and DC-0037 (16.70 t/ha) which well identical while the minimum yield was obtained from DC-0038 (9.50 t/ha). The highest statically similar individual fresh root weight was recorded from DC-0031 (173.00 g) and DC-0037 (175.50 g) while the minimum was recorded from DC-0028 (88.00 g). The maximum root length (20.30 cm) was recorded from DC-0032 which was identical to DC-0033 (20.05 cm) followed by DC-0033 (19.55 cm), DC-0034 (18.55 cm) and DC-0037 (18.55 cm). On the other hand the maximum diameter was observed in DC-0032 (4.66 cm). Three types of root color were observed among the lines *viz*., deep orange (1), orange (7) and red (1) and among these 9 lines rad no branching nature. All lines had seed production ability in local climate. Depending all the parameters the lines DC-0031, DC-0032, DC-0033 and DC-0037 may be selected for regional yield trial (RYT)

Stem amaranth

Collection and evaluation of stem amaranth at Narsingdi region

A study on eight stem amaranth germplasm with one check variety were evaluated at the research field of Regional Horticulture Research Station of BARI, Shibpur, Narsingdi during October 2019 to January 2020 for their yield, quality and virus resistance. The germplasm AT Nar-004 showed maximum plant height (96.37 cm) and stem length (88.06 cm). Minimum plant height (72.73 cm) and stem length (61.36 cm) was recorded from germplasm AT Nar-007. No. of leaves/plant was obtained highest (30.33) from BARI Stem Amaranth-1 and lowest (24.14) from AT Nar-001. Single plant weight was found highest (261.23 g) from AT Nar-004 and lowest (141.56 g) from AT Nar-008. Both yield/plot (15.67 kg) and yield (52.23 t/ha) was recorded highest from the germplasm AT Nar-004. On the other hand, lowest yield/plot (8.49 kg) and yield (28.30 t/ha) recorded from the germplasm AT Nar-008. Days to harvest found minimum (43-46 days) from the germplasm AT Nar-004 and maximum (61-64 days) from the germplasm AT Nar-008. Germplasm AT Nar-004 showed less susceptible to anthracnose disease and also very low aphid infestation compared with other germplasm and check variety.

Evaluation of stem amaranth lines at Jamalpur region

A study was conducted to evaluate stem amaranth (*Amaranthus tricolor*) lines in respect of yield and quality at HRC field, RARS, Jamalpur during the summer season of 2019 to release a new stem amaranth variety .Seventeen stem amaranth lines *viz*. ATJam-001, AT Jam -002, AT Jam -003, AT Jam -004, AT Jam -005, AT Jam -006, AT Jam -007, AT Jam -008, AT Jam -009, AT Jam -0010, AT Jam -0011, AT Jam -0012, AT Jam -0015, ATJam -0016, AT Jam -0018, AT Jam -0019, AT Jam -0020 and BARI Data-1 as check were evaluated to investigate the yield and yield contributing characters. Days to flowering was found late (65 days) in the line AT Jam-007 and early (39) in AT Jam -001. The maximum individual stem weight (252 g) was noted in the line AT Jam -016 and minimum (108 g) in the lineAT Jam -001. The highest yield per plot (17.89 kg) and per hectare (31.72 t) was produced by the line AT Jam -016 and second highest yield per plot (15.76 kg) and per hectare (27.95 t) was produced by the line AT Jam -003 as against the less 7.67 kg and 13.60 t was produced by the line AT Jam -001 respectively. The results revealed that the line AT Jam -002. AT Jam -003, AT Jam -007,AT Jam -0012 and AT Jam -0016 gave higher yield and the AT Jam -002, AT Jam -006, AT Jam -007, AT Jam -0012, AT Jam -0016 and AT Jam -020 showed longer edible stage.

Advanced yield trial of stem amaranth lines

The study was conducted with 07 stem amaranth lines at the research field of Olericulture Division , HRC, BARI, Gazipur during *Kharif*-1 season of 2020 to develop summer, early and late summer and high fiber containing variety of stem amaranth. Days to 50% flowering was varied from 38 to 54. The line AM-0017 took the minimum days (38 days) and the line AM-0047(54 days) took the longest days to 50% flowering. The tallest plant was exhibited from AM-0015 (111.67 cm) followed by AM-0006 (102.33 cm) and smallest plant were observed from AM-0053 (72.33 cm).The longest leaf length (19.00 cm) was obtained AM-0017, while the shortest(16.00 cm) leaf length by AM-0053.The highest leaf breadth (11.33 cm) was obtained by AM-0048, while the shortest leaf breadth by AM-0017(8.33 cm).The heaviest stem was obtained from the line AM-0047 (253.33 g) which was followed by AM-0063 (241.67 g), whereas the lightest stem was observed from AM-0006 (165.67 g).The longest stem length was obtained by AM-0015 (103.00 cm), while the shortest stem length by AM-0053 (62.67 cm).The widest stem breadth (1.87 cm) was obtained by BARI Data 1 which was statistically identical to AM-0047(1.80 cm), while the shortest stem breadth by AM-0017(1.10 cm). Based on days to edible stage of stem all the lines categorized in 2 groups. Five lines showed 40-45 days and 03 lines showed more than 45 days. In case of pigmentation, 01 line showed pink, 02 were red and 05 were green. On the basis of branching nature, 03 lines had no branch, 02 showed few branches and rest 03 lines had all along branches. All the lines showed erect nature, stem were conspicuous. Among the studies lines, 2 lines were developed fiberness at 25 days, 4 lines were at 35 days and 2 lines were 45 days after sowing From the study it may be concluded that on the basis of qualitative and quantitative characters four lines AM-0015, AM-0047, AM-0048, AM-0053, were selected for RYT.

Effect of planting time and cultivar on year round stem amaranth production

A field experiment was conducted at Regional Horticulture Research Station, BARI, Shibpur, Narsingdi during *rabi* season of 2019-20 to find out the optimum sowing time and variety of stem amaranth. Three planting time *viz*., (i) 5th November (ii) 5th december (iii) 5th January and three variety(s) *viz*., (i) AT Nar 004, (ii) AT Nar 005 (iii) BARI Stem Amaranth-1 were included in the experiment. Among three planting time, there was significant difference regarding yield. In case of planting time 5th November produced the highest yield (50.12 t/ha). The variety AT Nar-004 produced maximum yield (51.16 t/ha). On the other hand in case of interaction effect 5th November planting time and AT Nar-004 germplasm produced the highest yield (50.28 t/ha).

Lettuce

Advanced yield trial of selected lettuce lines

Three advanced lettuce lines with check (var. BARI Lettuce-1) were included in trial at the field of HRC, BARI, Joydebpur, Gazipur during *rabi* season of 2019-2020. 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/plant was counted from LT-11 (17.67) and the minimum were from from the LT-10 live (10). The highest marketable leaf yield was obtained from the live LT-11 (12.46 t/ha) followed by BARI Lettuce 1 (9.53 t/ha) and the lowest in LT-10 (4.59 t/ha). Most of the lines produced light green to deep green colored leaves. The lettuce line LT-11 and LT-12 produced attractive maroon colored leaves and leaf colour variety produced seed in local climatic condition. Considering marketable yield, leaf color and seed producing ability, the lines LT-11 and LT-12 were selected for RYT to develop a variety.

Effect of GA_3 and growing condition on emergence and seedling growth of lettuce seed

An experiment was conducted at the Research field of Plant Physiology Section, HRC, BARI, during 11 December 2019 to 14 January 2020 to examine the influence of GA_3 and to find out suitable growing condition for better seed germination of lettuce seeds. The experiment was conducted in RCBD with three replications. The experiment consisted of two GA_3 concentrations *viz.*, T_1 = 0.0 ppm (control) and T_2 = 10 ppm and four growing conditions. The four growing conditions were: G_1 = Seeding in polythene bag and placed in low light place, shaded by bamboo chatai with black polythene, G_2 = Seeding in polythene bag and placed in bright light place, kept open, G_3 = Seeding in seed bed and placed in low light place, shaded by bamboo chatai with black polythene and G_4 = Seeding in seed bed and placed in bright light place, kept open). Soaking of lettuce seeds in GA_3 10 ppm gave higher seed emergence percent, shoot length, root length, seedling length, seedling fresh weight, seedling dry weight, seedling length and seedling dry weight and seedling vigour index than that of distilled water (control) and seed growing condition. G_1 recorded maximum seed emergence percent,roott length, root dry weight. G_3 gave maximum seedling vigour index.T_2 x G_1 combination gave maximum seed emergence percent, seedling length, root dry weight and seedling vigour index. GA_3 @ 10 ppm in combination with bamboo chatai with black polythene can be recommended for seedling production of lettuce.

Organic

Evaluation of 3rd generation MAGIC population of tomato under organic practices

The study was carried out at the organic field of Olericulture Division aunder HRC, BARI, Gazipur during winter 2019-20 in order to develop 4th generation MAGIC lines and evaluation of 3rd generation lines. Eight sets of 3rd generation tomato lines, namely 7 x 11, 2 x 13, 17 x 12, 20 x 11, 30 x 16, 3 x 31, 8 x 33 and 1 x 26 were evaluated with three replications. Single fruit wt (g) was recorded highest in 2x13 (165.7 g) while lowest in 20x11 (40.9 g) TSS is a important quality criteria and crosses were varied significantly. Lycopene content of crosses statistically similar. It was revealed around 20 percent improvement made in the cross 1x26 while the 3 percent in 2x13. improvement of β-carotene also made in all crosses. it was ranged from 5 to 16 percent. it was varied significantly among the crosses. Cross 30x16 produced the highest amount of fruit/plant and it was around 3 kg. MAGIC breeding is an effective approach for improving the genotypes upto desired goal and in this study positive improvement was made over 1st generation population for phytochemicals like lycopene and B carotene content which ranged 3 to 20 percent. Final generation preparation and evaluation might conclude the improvement adequately.

Evaluation of nutrient dense pumpkin under conventional and organic management

The study was carried out at organic field and side by side conventional field of Olericulture Division under HRC, BARI during November 2019 to April 2020. Eight genotypes namely; BARI Mistikumra-2, NDP-1, NDP-2, NDP-3, MK-4, MK-31, BARI Mistikumra-1, MK-8, were evaluated at organic and conventional conditions with three replications. The organically managed soil were ploughed by power tiller in a mode of conservation tillage. organic fertilizer at the rate of 15 t/ha poultry manure were applied half amount during initial land preparation. After pulverized the soil, A 2 m bed was prepared and 50 percent of the rest amount organic fertilizers were applied in the bed. Pits were made at 100 cm apart and rest of the fertilizers were applied. The black silver color plastic film was used as mulch paper where black side given down side and silver was in upper to reflect light which help to prevent the attack from small flies. A whorl was cut (10 cm dia) a 100 cm apart and liquid fertilizers BARI IMO 1 and 2 were poured at the rate 100 ml per pit. For conventional methods fertilizers were applied as recommended by BARC (FRG 2018) for pumpkin production. Five true leaves seedlings were planted on 2 December 2019. Inter cultural operations were carried out as and when needed. Four fruits were kept at four individual vines of each plant. Data were recorded on yield contributing characters and quality parameters like Lycopene, β-carotene and TSS, and analysed statisticallyit is revealed that the studied parameters significantly varied. In case of single fruit weight genotypes were significantly varied but not varied in the production process. The heaviest fruits were recorded at MK 31 (2.12 to 2.36 kg) while the NDP 2 produced the lightest fruits (0.56 to 0.81 kg). The size were varied significantly. in case of β-carotene or pro-vitamin A the highest amount was recorded at BARI Mistikumra-2 while the lowest found at MK 31. In general organically grown pumpkin showed higher amount of lycopene and β-carotene than its conventional counter parts and its ranges from 20-35%. however, genotypes NDP 1, MK 8 and BARI Mistikumra-2 might be selected as high nutrient content line. Moreover, as the line possess diverse character thereby initiate MAGIC breeding with these genotypes for improved varieties.

Diversity of organic carrot

A total 29 lines were evaluated at olericulture division of HRC under BARI to study the diversity of carrot under organic condition in terms of provitamins and seed production potentiality as per IPGMR instructions during November 2019 – April 2020. The heaviest root was recorded in DCO 28 (185 g) and the lightest was in DCO 007 (35 g). The longest root was observed in the accession DCO 22 (16.2 cm) while the shortest by DCO 8 (6.5 cm). Wide range of variation was observed in core size from 0.8 - 4.1 cm. The smallest core was recorded at DCO 27 while the biggest was in DCO 16 (4.1). The highest TSS (°brix) was recorded at DCO 26 (10.1) while the lowest at DCO 16 (4.5). Yield of carrot per plot and ha were ranged 3.2 – 16.7 kg and 5.6 -29.6 t respectively. DCO 28 was the highest yielder of carrot under organic conditions. The highest amount of β-carotene was recorded in DCO 4 and DCO 28 followed by DCO 26, DCO 25 , DCO 17 while the lowest in DCO11. Wide difference was also observed while study the EIS value for understand the cellular structure. The line DCO 27, DCO 28, DCO 17, DCO 4 was selected for further improvement.

Evaluation of tomato genotypes under organic condition in pest exclusion net

The study was carried out at organic field at Olericulture Division under HRC, BARI during October 2019 to April 2020. Ten crosses of tomato, namely BARI Tomato-15xNew-23 (CR1) , AVTO Tomato-1258xKurian Red (CR 2) BARI Tomato-11x BARI Tomato-15 (CR 3), AVTO-1248xNew-9 (CR 4), New-22 x BARI Tomato-17 (CR 5), New-9 x New-101 (CR 6), Kurian Yellow x Bhutan (CR 7), New-5xNew-6 (CR 8), Kurian RedxNew-7(CR 9), and New-6xKurian Yellow (CR 10) were evaluated in three conditions pest exclusion net with mulch (P+M+), mulch without PEN(P- M+), control (P-M-) with three replications. Single fruit weight varied among tested cross of tomato. The heaviest fruit was recorded at CR 8 (106-123) followed by CR 3, CR 4 and CR 5 and the lightest fruit was in CR7 (12 g) followed by CR 10 CR 2. The fruit size and flesh thickness were not affected by mulch and PEN. More than 7 °brix was observed at the cross CR 7, CR 9 10 and around 6 recorded in CR 3, CR 6, the other line showed 5 or less. The highest plant height was recorded at the cross CR 6 and CR 10. Yield/plant was found the highest in CR 1, CR2 CR 5 and CR 10. Inside the PEN with mulch showed the more yield in most of the crosses. Lycopene and β-carotene amount were found different among the crosses. The cross CR 2, CR 5 and CR 9 showed the maximum amount of lycopene and β-carotene. Net and mulching did not influenced significantly on lycopene and β-carotene content

Indigenous vegetable

Evaluation of selected drumstick lines (on and off-season)

A study on evaluation of selected seven drumstick entries was conducted at the experimental field of Olericulture Division of HRC, BARI, Gazipur during the season of 2010-12 onward and this year (2019-20). The drumstick entry: MO 0025 was found to be as seasonal natured having good quality with average pod weight (61.53g) having 16.25kg yield/plant, while four lines *viz.*, MO 0001(1), MO 0007, MO-0008, MO-0011 and MO-0012 were considered as off-seasonal promising lines having 40-50g, average pod weight. Yearly average per plant yield indicated that the lines MO 0001(1) exhibited maximum yield (13.75 kg) followed by line MO 0012 (15.23 kg). These off-season lines were capable of producing flower two to three times in a year. No major pest and diseases was found to attack in the drumstick lines. The line MO0011 and MO0025 may be proposed for releasing as off and on season drumstick varieties, respectively. For further use, five plants of each entry are being multiplied.

Preliminary yield trial of selected underutilized indigenous vegetables

A study on six types of underutilized indigenous vegetables was put into PYT at the research field of Olericulture Division of HRC, BARI, Gazipur during 2019-20 to standardize production protocol for growing different time of the year. Different parameters *viz*., Plant height, number of branches per plant, number of leaves per plant, leaf length and width, days to harvest, days to flowering, plot and per hectare yield were recorded and analyzed. The yield potential of Bathua- green (12.35 t/ha), Bathua- red (13.45 t/ha), Thankuni (10.64 t/ha), Lafashak (17.70 t/ha), Pudina (10.35t/ha), Telakucha (8.40 t/ha) and Chukur (6.85 t/ha) was obtained. Further study, need to be performed to standardize the production practices. Among these entries, bathua and lafa may be put into regional yield trials at different AEZs of Bangladesh.

Evaluation and conservation of indigenous vegetables

Twenty eight types of underutilized indigenous vegetable 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 2019-20. The yield potentiality of Bathua - green (16 t/ha), Bathua - red (14 t/ha), Thankuni (8.50 t/ha), LafaShak (18.0 t/ha), Pudina (9.60 t/ha), Nunia (14.26 t/ha), Malancha (8.65 t/ha), Helencha (10.5 t/ha), ShialmutraShak (17.5 t/ha), Shaknotey (18.20 t/ha), Katanotey (16.48 t/ha) and Pat Shak (5.24 t/ha). However, further studies are required for the standardization of their production practices. More indigenous medicinal herbs have been collected and are being multiplying for further study.

Hydrophonic

Performance of indigenous and exotic leafy vegetables in two hydroponic nutrient formulations

An experiment was conducted in the glass house of HRC, BARI during the period from 19 January to 21 March 2020 to investigate the performance of eleven indigenous and exotic leafy vegetables under two types of hydroponic nutrient solution. The selected leafy vegetables includes Spinach var. BARI PalongShak - 1, Chard var. (not provided), Lettuce var. BARI lettuce - 1, Salad Green, Red Romaine, Rainbow Irona, China Shak var. BARI China Shak - 1, Pak-choi var. BARI BatiShak - 1, Mizuna var. Purple, Green and Rocket salad var. (not provided). Nutrient solutions used were modified Cooper’s solution (1.5 dS/m EC) and Enshi-shoo nutrient solution (50%). Deep water culture technique was followed to grow the selected leafy vegetables in low cost wooden boxes in floor of glass house where plastic polythene was used for holding nutrient solution. Nutrient solutions were circulated periodically by moving the water around using an automatic timer (10/30 min.; operation/stop). It was found that growth of selected leafy vegetables was varied significantly in two types of nutrient solution. BARI PalongShak - 1 and Rocket salad performed better in modified Cooper’s nutrient solution while Chard, Mizuna (both purple and green) showed better performance in Enshi-shoo solution. Lettuce varieties were less influenced by the types of nutrient solution indicating its sensitiveness toward hydroponic nutrient composition. Therefore, choice of leafy vegetable for both growth and quality characteristics is variable and can be selected according the above results.

Demonstration of simplified hydroponics at different locations of Bangladesh

This study was conducted to demonstrate and extend the simplified hydroponics techniques to different locations of Bangladesh including regional stations of BARI. Initially two simplified hydroponic systems were established at

Agricultural Research Station, Pahartali, Chattogram during winter season of 2019-20. They include deep water culture technique in plastic trays and an elevated bench system using plastic sheet channels filled with coco-coir. Lettuce and capsicum were grown in growing bed where nutrient solutions re-circulated from a reservoir tank. While strawberry and tomato was grown on the plastic channel filled with coco-coir. Yield was calculated for lettuce and strawberry from this trial. A total of 40 tomato plants were accommodated in an area of 8.92 m^2 and the total yield obtained was 120.0 kg. The yield per plant was recorded as 3.0 kg, which is comparable to soil culture. In plastic tray (4.46 m^2), total 36 lettuce plants were accommodated yielding 10.04 kg with average head weight of 279 g. In case plastic channel with soilless culture (8.92 m^2), total 24.75 kg fruits were harvested from 66 strawberry plants with average yield of 375 g per plant. Initially several fixed and variable cost involved for establishing the structure, hydroponic systems, necessary tools and materials and hydroponic fertilizer. Initially three horticultural crops such as lettuce, tomato and strawberry were cultivated and profitability will be calculated from the next year.

Standardization of hydroponic nutrient solution for growing vegetables

A study was conducted in the Molecular Laboratory, Olericulture Division, HRC of Bangladesh Agricultural Research Institution (BARI), Gazipur, Bangladesh to standardize the hydroponic solution developed by Olericulture Division. Research activities including nutrient solution preparation, analysis for chemical composition determination were done during September 2019 to May 2020. Four concentrations of proposed hydroponic solution include tap water (control), 1.0, 1.5, and 2.0 dS/m. Physical characteristics such as color, state, specific gravity, solubility, pH and flammability, and chemical composition such as N, P, K, Ca, Mg, S, Fe, Mn, B, Cu, Na, Zn and Mo were determined. Based on the chemical analysis reports, an application was sent to the Technical Sub-Committee (Fertilizer), BARC, Farmgate, Dhaka-1215 for standardization. The standardized hydroponic solution will be used as BARI Hydroponic Solution - 1.

Performance of different cultivars of capsicum in coco coir substrate through hydroponic culture

The experiment was conducted at the net house of Olericulture Division, HRC, BARI, Joydebpur, Gazipur on September, 2019 to March, 2020 to evaluate the performance of different capsicum variety in coconut coir based substrate using low cost hydroponic solution. Two capsicum advanced hybrid lines, namely $H_1= P_2 \times P_5$ and $H_2=P_5 \times P_9$along with M_1= BARI Mistimorich-1 as control variety. “Low cost Hydroponic solution-A, B and C” were used to culture the plants. This hydroponics solution is modified Cooper’s solution.The Maximum fruit yield/plant was recorded from H_2 (1.34 kg) while the minimum was recorded from H_1 (0.84 kg) which was identical to BARI Mistimorich-1 (0.91 kg). The Maximum TSS was recorded from BARI Mistimorich-1 (5.33) while the minimum was recorded from H_1 (5.06) which was identical to H_2 (5.10). The Maximum Vitamin C content was found from H_1 (231.7 mg/100 g) while the minimum was recorded from H_2 (200.1 mg/100 g).

Performance of BARI released summer tomato varieties on soilless culture through low cost hydroponic solution

The experiment was conducted at the Hydroponic net house-2 at Olericulture Division, HRC, BARI, Joydebpur, Gazipur on April-September, 2019 to evaluate the performance of summer tomato low cost hydroponic solution. BARI released three hybrid summer tomato varieties *viz*., BARI Hybrid Tomato-8, BARI Hybrid Tomato-10 and BARI Hybrid Tomato-11 were used for the experiment. “Low cost Hydroponic solution-A, B and C” were used to culture the plants. The maximum number of fruit was found from the BARI Hybrid Tomato-11 (46.0) while the minimum was recorded from the BARI Hybrid Tomato-8 (34.4). The maximum fruit length was observed in BARI Hybrid Tomato-8 (5.2 cm) while the minimum from BARI Hybrid Tomato-10 (4.6 cm) but the maximum fruit width was recorded from BARI Hybrid Tomato-8 (5.6 cm) on the other hand the minimum was found from BARI Hybrid Tomato-10 (4.6 cm). The maximum individual fruit weight was observed in BARI Hybrid Tomato-8 (92.8 g) while the minimum was recorded from the BARI Hybrid

Tomato-10 (74.8 g). The maximum yield per plant was recorded from the BARI Hybrid Tomato-11 (3.20 kg) which was statistically similar to BARI Hybrid Tomato-8 (2.94 kg) while the minimum was found from the BARI Hybrid Tomato-10 (2.50 kg). The maximum TSS value was observed in BARI Hybrid Tomato-10 (5.4) which was statistically similar to BARI Hybrid Tomato-11 (5.3) on the other hand the minimum was found from the BARI Hybrid Tomato-8 (4.8). Considering all the parameters BARI Hybrid tomato-11 and BARI Hybrid tomato-8 performed best and gave the maximum output and yield (3.20 kg/plant and 2.90 kg/plant respectively).

Calculation of benefit cost ratio of lettuce and tomato grown in hydroponics culture

The experiment was conducted at the Hydroponic net house-2 at Olericulture Division, HRC, BARI, Joydebpur, Gazipur on May-August, 2019 to evaluate the performance of different tomato and lettuce varieties in hydroponic system using hydroponic solution. BARI released two tomato varieties *viz*., BARI Hybrid Tomato-8 and BARI Hybrid Tomato-10 were used and two lettuce varieties were for the experimental crop. Hydroponic solution-A and B were used in this experiment. The maximum yield for lettuce was 16.65 kg from two culture tray and BCR was 1.74 and for tomato, the maximum yield of summer tomato was 36.40 kg from two culture tray for consecutive 2 months and BCR was 2.11. This high BCR value denotes that hydroponic cultivation is more profitable than field cultivation.

Production of capsicum through hydroponic culture

The experiment was conducted at the poly house on the rooftop of RHRS, BARI, Lebukhali, Patuakhali during the winter season of 2019-20 to study the feasibility of growing capsicum vari. BARI Mistimorich-2 in rooftop and to increase vegetable production in the city areas. In the capsicum bed, plant height varied from 32 cm to 45 cm. Days to first harvest varied from 70 to 74 days. No. of fruits per plant was 14-18. Average fruit weight was 75.2 g and maximum fruit weight was 80 g. On an average 1.2 kg marketable capsicum could be harvested from a single plant. Production of capsicum through hydroponic technique could be beneficial to farmers and rooftop gardeners for high economic return.

Performance of lettuce in recirculating and performance of tomato & strawberry in coco-coir hydroponics system

These experiments were conducted in Agricultural Research Station (ARS), Pahartali, Chattogram during 2019-20 to observe the feasibility on hydroponics system for vegetable production in Chattogram region. The yield of strawberry was found 10.04 kg from 4.46 m^2 area. Total 24.75 kg of strawberry was harvested from 8.92 m^2 area. Total 120 kg of tomato was harvested from 8.92 m^2 area. The fruits were smooth and attractive in color.

Survey and monitoring of fall armyworm (*Spodoptera Frugiperda*) on maize and vegetable crops at different regions of Bangladesh

The survey and Monitoring on Fall Armyworm were done in Research and growers' maize, tomato, cauliflower and cabbage fields of eight locations, such as Bogura, Cumilla Gazipur, Kishoregonj, Kustia, Manikgonj, Pabna and Rangpur from December 2019 to March 2020 and only Gazipur and Bogura during April-June-2020. Results revealed thatFall armyworm infestation was observed only on Maize but not on tomato, cauliflower and cabbage. The highest infestation and capture were observed during summer season as compared to winter season. The highest plant infestation was recorded at Bogura both in winter (23.5%) and summer season (72.25%). Maximum plant showed the damage score-1 (51.08%) with very few exception irrespective of locations followed by damage score-2 (27.06%) and damage score-3 (21.86%).

06 FRUIT CROPS

Project: Varietal development

Evaluation of jackfruit germplasm at Joydebpur

Ten jackfruit germplasm *viz*., AH Joy-032(3), AH Joy-039(2), AH Joy-076 (2), AH Joy-078, AH Joy-099, AH Joy-115, AH Joy-202, AH Joy-203, AH Joy-215 and AH Joy-218 were evaluated to identify the superior ones at the Fruit Research Farm of HRC, BARI, Gazipur. Wide range of diversity was manifested in the tree characters, number of fruits/plant, fruit characters and pulp characters of jackfruit. Maximum plant height was recorded to be 7.35 m in AH Joy-203 and minimum plant height in AH Joy-115 (3.95 m). Base girth ranged from 58 cm in AH Joy-039 (2) to 120 cm in AH Joy-215. Trunk height varied from 0.88 m to 2.20 m. Number of fruits ranged from 7 to 50. Individual fruit weight ranged from 2.70 to 12.50 kg. Fruit length varied from 22.0 to 54.0 cm whether diameter varied from 15.0 to 26.0 cm. Maximum and minimum bulb weights were recorded to be 5.98 in AH Joy-218 and 1.30 kg in AH Joy-039(2), respectively. Number of bulbs/fruit varied from 52 in AH Joy-099 to 266 in AH Joy-218. Maximum and minimum edible portion were manifested to be 56.3 and 50.0 % in AH Joy-215 and AH Joy-039 (2), respectively. TSS content was noticed to vary from 17.0 to 27.0 º Brix. With respect to number of fruits/plant, fruit weight, edible portion, TSS content and pulp quality, germplasm AH Joy-202, AH Joy-218, AH Joy-215, AH Joy-115 and AH Joy-078 were found superior.

In-situ evaluation of some selected heavy bearing type jackfruit germplasm

Six jackfruit germplasm *viz*., AH Joy-261, AH Joy-262, AH Joy-263, AH Joy-264, AH Joy-265 and AH Joy-266 were evaluated to identify the superior ones as profuse bearer and family size jackfruit in the jackfruit growing areas of Gazipur and Tangail. Age of tree ranged from 20 to 32 years. Number of fruits varied from 168 to 502. Age of tree ranged from 20 to 32 years. Fruit weight ranged from 2.73 to 5.85 kg. Fruit length varied from 17.2 to 29.8 cm whether diameter varied from 15.0 to 21.2 cm. Maximum and minimum individual bulb weights were recorded to be 23.5 g in AH Joy-264 and 14.6 g in AH Joy-265, respectively. Number of bulb/fruit varied from 93 in AH Joy-261 to 160 in AH Joy-264. Maximum and minimum edible portion were manifested to 64.1% in AH Joy-264 and 46.8 % in AH Joy-263, respectively. TSS was noticed to vary from 18.0 to 25.0 º Brix.

Performance of BARI developed jackfruit varieties at Joydebpur

An experiment was performed at the Fruit Research Farm, HRC, BARI, Joydebpur, Gazipur to observe the performances of BARI developed jackfruit varieties *viz*. BARI Kanthal-1 (harvested during mid-May to June); BARI Kanthal-2 (harvested during January to March) and BARI Kanthal-3 (harvested during September to June). Saplings of jackfruit varieties were planted in June, 2018. Total number of grafted saplings was 36. Spacing was 5 X 4.5 m. Pit size was 1m x 1m x1m. The experiment was laid out in RCBD with 12 replications. Plant heights on June 30, 2019 of BARI Kanthal-1, BARI Kanthl-2 and BARI Kanthal-3 were recorded 1.34 m, 0.90 m and 0.90 m, respectively and at June, 2020 plant heights of BARI Kanthal-1, BARI Kanthl-2 and BARI Kanthal-3 were recorded 3.04 m, 2.91 m and 2.92 m, respectively. At the same time, base girth increased from 5.43 cm in June, 2019 to 17.6 cm in June, 2020 in the case of BARI Kanthal-1; 4.14 cm in June, 2019 to 20.5 cm in June, 2020 in case of BARI Kanthal-2 and 4.01 cm in June, 2019 to 20.3

cm in June, 2020 in the case of BARI Kanthal-3. From June, 2019 to June, 2020, plant height increased 127% in BARI Kanthal-1, 223% in BARI Kanthl-2 and 224% in BARI Kanthal-3, respectively. Number of branches and number of leaves increased simultaneously.

Survey on identification and collection of year round and off-season jackfruit germplasm

Survey on identification of year round and off-season jackfruit germplasm in Gazipur, Khagrachari and Narsingdi districts were carried out. Fifty farmers of each district were selected randomly for interviewing to collect the information of year round and off-season jackfruit germplasm. Seven off-season/year round jackfruit germplasm were identified ; one off-season jackfruit germplasm (AH Joy-254, harvested during December to June); a two season jackfruit germplasm (AH Joy-256) and one year round jackfruit germplasm (AH Joy-255) were identified at Gazipur; three year round jackfruit germplasm (AH Ram-257, AH Ram-258 and AH Ram-259) were identified at Ramgarh, Khagrachari. One year round jackfruit germplasm (AH Nar-260) was identified at Narsingdi.

Evaluation of jackfruit germplasm at Jamalpur

The study was conducted at the Regional Agricultural Research Station, Jamalpur. Six jackfruit germplasm *viz*., AH Jam-002, AH Jam-003, AH Jam-018, AH Jam-022, AH Jam-023 and AH Jam-024 were selected for the study. A wide variability was observed in different parameters such as weight of individual fruit, number of fruits/tree, size of fruit, shape of fruit, percent edible portion and percent TSS among the germplasm studied. The highest number of fruits per plant (150) was observed in AH Jam-003 and the lowest (50) number of fruits was recorded in AH Jam -024. The highest edible portion (73-75%) from green jackfruit was obtained from AH Jam-018 and the lowest (59-61 %) edible portion was obtained from AH Jam-024. But the highest edible portion (63%) from ripe jackfruit was obtained from AH Jam-002 and the lowest edible portion (52 %) was obtained from AH Jam-24. Maximum TSS was obtained from AH Jam -002 (22 %) followed by AH Jam-003 and AH Jam-018 (21). The lowest TSS was manifested in AH Jam-024 (17.o%). Considering fruit characteristics i.e. taste, sweetness, texture of bulb, bulb color, fruit size, TSS, edible portion and fruit yield of germplasm; AH Jam-002, AH Jam-003, AH Jam-018, and AH Jam-023 were found to be suitable for both of cooking and table purpose.

Evaluation of jackfruit germplasm at Chapainawabganj

An experiment was carried out with two jackfruit germplasm, namely AH Cha-001 and AH Cha-002 at RHRS, Chapainawabganj in order to know the detailed information on plant growth, fruit characteristics and yield. Between two jackfruit germplasm, maximum tree volume was recorded in AH Cha-002 (190.4 m^3) and minimum tree volume was recorded in AH Cha-001(164.9 m^3). Fruit weight was maximum in AH Cha-002 (7.00 kg) while minimum value was recorded in AH Cha-001 (5.25 kg). The highest yield of fruit was recorded in AH Cha-001 (131.3 kg) while the lowest yield was recorded in AH Cha-002 (70.0 kg). Maximum bulb weight was noted in AH Cha-002 (44.50 g) while minimum bulb weight was noted in AH Cha-001 (40.8 g) and the highest TSS (20.3 %) was recorded from AH Cha-002 while minimum (18.5 %) TSS was noticed in AH Cha-001. Diseases and insect-pests were absent in two jackfruit germplasm.

Evaluation of superior jackfruit lines at Jaintapur

The study was conducted at the Citrus Research Station, Jaintapur, Sylhet. Six jackfruit lines were selected for the study. A wide variability was observed in different parameters such as weight of fruit, number of fruits/tree, size of fruit, shape of fruit, number of bulbs/fruit, percent edible portion and percent TSS among the germplasm studied. AH Jai-078 was noticed superior with the highest number of fruits (180)/plant followed by AH Jai-005 (155). Among the accessions, fruits of AH Jai-078 were harvested in early March which was considerably early and AH Jai-101 was late in the fruiting season. The highest edible portion was found in AH Jai-095 (50.9%) whereas the lowest edible portion was noted in AH Jai-005 (32.5%). Maximum TSS (23.2%) was found inAH Jai-005 whereas minimum TSS was recorded inAH Jai-095 (18.3%).

Evaluation of existing superior jackfruit germplasm at Pahartali

An experiment was conducted at the Agricultural Research Station, Pahartali, Khulshi, Chattogram to evaluate promising lines and to select desirable Jackfruit lines with higher yield and qualities. Among the tested genotypes, earliest flowering was observed in AH Pah-004 (Mid December) and the latest flowering was observed in AH Pah-001 and AH Pah-005, respectively (Late January). Maximum number of fruits/plant (103) was produced by AH Pah-004 where minimum number (17) was produced by AH Pah-007. The heaviest fruit was observed in AH Pah-002 (7.81 kg) and the lightest was observed in AH Pah-004 (3.52 kg) followed by AH Pah-007 (3.66 kg). Maximum yield of fruits/plant (362.6 kg) was produced by AH Pah-004 where minimum yield (62.22 kg) was produced by AH Pah-007. Maximum number of bulbs (124) was produced by AH Pah-002 where, minimum bulbs (20) were recorded in AH Pah-007. Maximum weight of bulbs/fruit (3.65 kg) was produced by AH Pah-005 and minimum weight of bulbs was produced by AH Pah-007 (1.28 kg). Individual bulb weight was higher (48.84 g) in AH Pah-007 where, the lowest (30.0) bulb weight was registered in AH Pah-003. Maximum bulb size was produced in AH Pah-002 (7.31 cm x 3.67 cm). Edible portion was recorded the highest (59.66 %) in AH Pah-004 followed by AH Pah-001 (50.9 %) where the lowest (35.5%) edible portion was noticed in AH Pah-007. TSS was noted the highest (21.1) in AH Pah-002 followed by AH Pah-004 (20.4 %). The bulbs of AH Pah-004 were excellent in taste.

Collection and evaluation of year round off-season jackfruit germplasm in Cumilla region

Two identified year-round and off-season jackfruit germplasm; AH Cum-101 and AH Cum-102 were evaluated at the Regional Agricultural Research Station, Cumilla. Both the germplasm showed better performance regarding bearing habit, quality, yield and yield contributing characters. Number of fruits/plant was observed 34 in AH Cum-101 and 11 in AH Cum-102. TSS was noted in AH Cum-102 followed by AH Cum-101. Considering the yield and yield contributing attributes, the germplasm AH Cum-102 exhibited superior results.

Evaluation of jackfruit germplasm in the hilly region

Eleven jackfruit germplasm were evaluated at the fruit farm of HARS, Khagrachari during the year 2019-20 to identify superior small sized jackfruit germplasm with high yield potentiality and edible qualities. Yield and yield components of the jackfruit germplasm were studied. Number of fruits/plant ranged from 52-123. AH Kha-006 produced maximum number of fruits (123) followed by AH Kha-005 (117) and minimum number of fruits was recorded in AH Kha-004 (52). Single fruit weight ranged from 2.90 to 3.90 Kg where AH Kha-003 produced the highest (3.90 kg) individual fruit weight and the lowest fruit weight was found in AH Kha-002 (2.90 kg). TSS content of the fruit varied from 17 to 27.1% where the highest TSS (27.1%) was recorded in AH Kha-010. The highest fruit yield (442.8 kg/plant) was observed in AH Kha-006 and the lowest yield was noted in AH Kha-004 (166.6 Kg/plant). The edible portion varied from 36.65% to 52.67% where AH Kha-005 showed the highest (52.6 %) edible portion followed by AH Kha-007 (52.3%) and the lowest edible portion was observed in AH Kha-008 (36.6 %). Considering fruit characteristics i.e, taste, juiciness, sweetness, colour of pulp, fruit number and yield, the germplasm AH Kha-005, AH Kha-006 and AH Kha-007 were found to be suitable superior small sized jackfruit germplasm with high yield potentiality and edible qualities.

Evaluation of exotic jackfruit germplasm at Joydebpur

Eight exotic year round jackfruit germplasm with three red jackfruit germplasm were studied at the Fruit Research Farm, Joydebpur. Plant height, base girth, plant spreading and male inflorescences were recorded. The average plant height was observed to be 3.03 m. Maximum plant height was recorded in AH Exo-03 and AH Exo-06 (3.4 m) and minimum in AH Exo-11 (2.9 m). Nine germplasm were observed to produce male inflorescences from the second week of November, 2019 which was the sign of off-season and year round behaviour. Male inflorescences were observed from the first year of planting, but female inflorescences were not found. Male inflorescences were observed in nine exotic year round jackfruit germplasm, but no female inflorescences were appeared. Experiment will be conducted in the next year for further evaluation.

Evaluation of superior mango genotypes at Pahartali

An experiment was conducted at the Agricultural Research Station, Pahartali, Khulshi in Chattogram during 2017-18, 2018-19 and 2019-20 to identify promising mango lines for higher yield and qualities. Two genotypes of mango, namely MI Pah-002 and MI Pah-003 were identified before and were evaluated. Between them, earliest flowering and harvesting were observed in MI Pah-002 and the latest in MI Pah-003. Maximum number of fruits (126)/ plant was produced by MI Pah-003 and minimum number of fruits (48)/plant was produced by MI Pah-002. The heaviest fruit (482.82 g) was observed in MI Pah-003 and the lightest fruit (241.9 g) was observed in MI Pah-002. The highest edible portion (72.67%) was achieved from MI Pah-003 and the lowest edible portion (68.39 %) was achieved from MI Pah-002. Maximum Total Soluble Solids (TSS) (18.23 %) was observed in MI Pah-002 and minimum (17.47 %) TSS was observed in MI Pah-003. The highest yield per tree (62.0 kg) was produced by MI Pah-003 and the lowest yield per tree (18.57 kg) was produced by MI Pah-002. Maximum fiber (2.4) was found in MI Pah-002 while the minimum fiber was recorded in MI Pah-003 (2.5). Very good organoleptic taste was found in MI Pah-003 and in MI Pah-002.

Evaluation of mango germplasm at Jamalpur region

An experiment was conducted to identify suitable mango germplasm (*Mangifera indica*) at Fruit Orchard of HRC, RARS, Jamalpur. Maximum plant height was recorded in MI Jam-003 (2.13 m) and minimum plant height was noted in MI Jam-006 (0.75 m). Maximum base girth was obtained from MI Jam-003 (28.3cm) and minimum in MI Jam-005 (7.66 cm). The highest canopy spread was observed in MI Jam-003 (1.96 m x 1.75 m) and the lowest canopy spread was noted in MI Jam-008 (0.30 m x0.30 m). Maximum tree volume was obtained from MI Jam-003 (3.81 m^3) and minimum in MI Jam-005 (0.04 m^3).

Exploration and collection of mango germplasm

Exploration and collection programme were conducted on mango (*Mangifera indica*) germplasm in 4 upazilas of 2 districts in Bangladesh. Twenty two germplasm of mango were collected from 4 upazilas of Jamalpur and Sherpur districts. The germplasm were collected from farmers’ home garden. The status of the sample was landraces. The samples were collected as scion from individual plant or population. Passport data like crop name, collector’s number, local or cultivar name, sample status and source, date of collection, name of village, union, upazila and district were recorded.

Morphological characterization and evaluation of mango germplasm

Studies were carried out on mango germplasm collected from different parts of the Cumilla region to develop a descriptor . The experiment was laid out at the Regional Agricultural Research Station, BARI, Cumilla with 24 lines as treatments. Observations were recorded on various morphological parameters such as qualitative and quantitative characters. Only 10 germplasm gave flowers and fruits this year and data were taken accordingly. Data will be recorded for three consecutive years, 2019-2020-2021. From the observations made it was found that the mango varieties expressed the morphological variations from genotype to genotype. These morphological variations have the ability to distinguish between the mango lines with each other. Descriptors are being developed initially for 24 mango genotypes on different observations, which consist of 31 qualitative and 18 quantitative characters. The developed and documented descriptors will facilitate in plant variety registration, identification of genotypes and also in mango improvement programmes.

Hybridization in mango at Burirhat

The popular mango varieties; Langra, Haribanga, BARI Aam-3, BARI Aam-4 and BARI Aam-11 have huge demand to people for their unique taste and high nutrient content. To mitigate the growing demand of popular mango as well as to improve the export potentiality, a hybridization programme was conducted following half-diallel fashion at the Fruit Research Farm, HRC, BARI, Gazipur to develop superior hybrids with desirable characters of mango. The cross combinations were; Harivanga x BARI Aam- 4, Harivanga x BARI Aam- 3, Langra x BARI Aam-3, Langra x BARI Aam-4, Harivanga x BARI Aam- 11, BARI Aam-3 x BARI Aam-4, Langra x BARI Aam-3 and Langra x BARI Aam-4. A total of 1125 flowers from 155 panicles were emasculated and pollinated. Three fruits were obtained only from BARI Aam-3 x BARI Aam-4. These mango hybrid fruits were harvested at mature stage and stones of the ripen fruits were sown in soil for germination in polybag in the net house. After germination, the performance of these hybrid seedlings will be evaluated in the following seasons for further variety improvement programme.

Hybridization in mango at RARS Cumilla

A hybridization program was conducted in the flowering season of 2020 at RARS, Cumilla. A total of 1213 flowers from 117 panicles were emasculated and pollinated. Twenty six fruits from the crosses were set initially but all fruits dropped before getting matured. However, this was the first time attempt of mango hybridization program in RARS, Cumilla. The study will be continued.

Inter-varietal hybridization of mango at Chapainawabganj

A hybridization programme was conducted in the flowering seasons of 2020 at RHRS, Chapai nawabganj. A total of 2384 flowers from 442 panicles were emasculated and pollinated. Ten hybrid fruits were obtained from the cross BARI Aam-3 x Palmer. These mango hybrid fruits were harvested at mature stage and stones of the fruits were sown in soil for germination in the hybrid seedling plot. After germination, these one year hybrid seedlings will be transplanted in the main field after khasi and will be evaluated in the following seasons.

Inter-varietal hybridization of mango at Burirhat

A hybridization program was conducted in the flowering season of 2020 at Regional Agricultural Research Station, Burirhat, Rangpur. A total of 3500 flowers from 380 panicles were emasculated and pollinated. Seven hybrid fruits were obtained from the crosses between BARI Aam-3 x BARI Aam-4. These mango hybrid fruits were harvested on 14 July 2020 at mature stage and stones of the fruits were sown in the soil for germination. After germination, these hybrid seedlings will be planted in the main field for evaluation in the following seasons.

Performance of some mango hybrids

An experiment on performance of some mango hybrids was carried out with 03 mango hybrids, namely Hy-058, Hy-059 and Hy-106 at RHRS, Chapainawabganj to know the detailed information on plant growth, fruit characteristics and yield. Among the mango hybrids, the maximum tree volume was recorded in Hy-059 (369.71 m^3) and the minimum was recorded in Hy-106 (118.00 m^3). Fruit weight was maximum in Hybrid-106 (650. 00 g) while the minimum was in Hybrid-058 (240.00 g). The highest yield of fruit was recorded in Hy-106 (162.00 kg) while the lowest yield was in Hy-058 (48.00 kg). Hy-106 had maximum edible portion (88.46%) whereas minimum (74.71 %) was in Hy-059. The highest TSS (25.50 %) was recorded from Hy-106 while minimum (21.00%) was in Hy-059. Highest fruit fly infestation at the time of harvest was recorded in Hy-106(15.50 %) while low infestation was found in Hy-058(10.50 %). The mango hybrid Hy-106 showed the highest disease incidence (18.10%) while the lowest was found in Hy-058(15.20%). Stem end rot was absent in all the mango hybrids. Maximum shelf life was found in Hy-106(9 days) and minimum shelf life was found in Hy-058 (8days) and Hy-059 (8 days).

Evaluation of mango hybrids

An experiment on the evaluation of mango hybrids were found from the previous year hybridization program, at Regional Agricultural Research Station, Burirhut, Rangpur to know the detailed information on plant growth characters . Nine hybrid stones were planted in the seed bed on 9 July 2018 for germination. From nine stones five hybrids were germinated and germinated seedlings were in vegetative stage in the main field for further evaluation.

Evaluation of green immature (kachamitha) mango germplasm at hill valley in Chattogram hill tracts

An experiment was conducted on the existing six years old mango orchard with MI Rai-005, MI Rai-006, MI Rai-007, MI Rai-008 germplasm and BARI Aam-9 (kachamitha mango as control treatment) at the hill valley of the Hill Agricultural Research Station of Raikhali, Kaptai in Rangamati Hill District during 2019-20 to find out the best kachamitha mango germplasm. The highest number of fruits per plant (99) was found in MI Rai-008 and the lowest number of fruits per plant (42) was in MI Rai-006. The heaviest individual fruit weight (253 g) and the highest edible portion (80.1%) were recorded in MI Rai-008 on the other hand the lowest fruit weight (111 g) was found in MI Rai-007. Maximum TSS (11%) was found in germplasm MI Rai-008. The germplasm MI Rai-008 was found very well in organoleptic test. No fruit was harvested from BARI Aam-9 during 2019-20 fruiting season.

Characterization and evaluation of late mango germplasm

An experiment on characterization and evaluation of late mango germplasm was conducted at the Fruit Research Station, Rajshahi. The experiment included only one late mango germplsm (MI Raj-002) which flowered two times in a year. First flowering occurred in the month of February in which fruits were harvested in the mid-season (June) and second flowering occurred in the month of May in which fruits were harvested in the late season (September). The germplasm MI Raj-002 produced 186 in number and 46 kg of fruits in the mid-season (February- June) production. In case of late season production, tree bore 155 in number and 27 kg of fruits. The individual fruit weight of MI Raj-002 was 270 g in the main season and 182 g in the late season (May-September, 2019). TSS percentage of main season fruit was 17 while it was21 in late season fruit. The overall performance of the germplasm MI Raj-002 was satisfactory.

Performance of BARI developed mango varieties at Chattogram hill tracts

An experiment was conducted on the existing eleven 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 to verify their performance. Maximum plant height (805 cm), number of fruits/plant (253) and fruit yield (23.5 t/ha) were observed in BARI Aam-8. The heaviest fruit (370g), the highest fruit breadth (9.2 cm) and fruit thickness (7.3 cm) were found in BARI Aam-4. Maximum TSS (12.5%) and edible portion (81.5%) were recorded in BARI Aam-2. The lowest number of fruits/plant (124), edible portion (64.9%) and fruit yield per plant (5.9 t/ha) were found in BARI Aam-1. Based on number of fruits/plant and fruit yield with higher TSS , individual fruit weight, fruit volume, edible portion BARI Aam-8, BARI Aam-3 and BARI Aam-4 were found superior.

Performance of green mango (kanchamitha) germplasm at hilly region

An experiment was conducted to evaluate one green unripe (Kanchamitha) mango germplasm (MI Kha-001) at the Hill Agricultural Research Station, Khagrachari. The full blooming period was the end of January. The tree habit was spreading to intermediate type. Harvesting period was 7 to 11 May, 2020. Total Soluble Solids (TSS) was recorded 9.75%. Edible portion was found 80.40%. Overall growth conditions of the germplasm were found satisfactory. Considering the fruit characters and edible quality MI Kha-001 was considered as a promising mango germplasm for using at unripe condition.

Evaluation of local mango germplasm at Akbarpur

An experiment was conducted at the Regional Agricultural Research station, Akbarpur, Moulvibazar with fourteen local mango germplasm (MI Akb-001, MI Akb-002, MI Akb-003, MI Akb-004, MI Akb-005, MI Akb-006, MI Akb-007, MI Akb-008, MI Akb-009, MI Akb-010, MI Akb-011, MI Akb-012, MI Akb-013 and MI Akb-014). A wide variation was observed regarding number of fruits/plant, fruit weight, edible portion and TSS of different germplasm tested. The highest number of fruits/plant (700) and the highest fruit yield/plant (105 kg) were obtained from MI Akb-009. The highest fruit weight was recorded from MI Akb-

001 (260.4 g) followed by MI Akb-002 (251.4 g) and MI Akb-006 (237.8 g). Edible portion was found the highest in MI Akb-002 (59.82%) whereas, maximum TSS (18.1%) was obtained from MI Akb-003.

Characterizati on and evaluation of mango chance seedlings obtained from MI Cha L-001

Three mango chance seedlings (MI ChaCS-01, MI ChaCS-02 and MI ChaCS-03) obtained from MI ChaL-001 were characterized and evaluated at the Regional Horticulture Research Station, Chapainawabganj . Among the three chance seedlings only two produced flowers and fruits in 2020. The individual fruit weight of MI ChaCS-01 was noted 726.7 g whereas MI ChaCS-02 produced fruit of 300 g. Both the germplasm had the capability of late season fruit production. MI ChaCS-01 and MI ChaCS-02 produced greenish yellow colour but MI ChaS-01 produced attractive and good quality fruits. MI ChaCS-02 having pleasant pulp flavour like Langra variety. MI ChaS-01 recorded 78 % edible portion and 20 % TSS while MI ChaCS-02 noted 68% edible portion and 18 % TSS, respectively. The germolasm MI ChaCS-01 produced 26 number and 18.89 kg of fruits whereas MI ChaCS-02 produced 15 number and 4.5 kg of fruits in 2019-20.

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. The tree was intermediate type of habit. In bagging MI Raj-001 mango germplasm, the average fruit length, breadth, fruit weight, skin weight, edible portion and TSS were 12.09 cm, 10.22 cm, 620.2 g, 76.2 g, 76% and 17.5%, respectively. Further, in non-bagging of MI Raj-001 mango germplasm, the fruit length, breadth, fruit weight, skin weight, edible portion and TSS were 10.91cm, 8.44 cm, 517.5 g, 69.5g, 74% and 19.2%, respectively. Whereas, in bagging, BARI Aam-4 (check variety), the average fruit length, breadth, fruit weight, skin weight, edible portion and TSS were 13.1 cm, 11.9 cm, 689.2 g, 78.5 g, 77% and 22.0%, respectively. Further, in non-bagging BARI Aam-4 (check variety), the fruit length, breadth, fruit weight, skin weight, edible portion and TSS were 11.2 cm, 10.03 cm, 610.4 g, 73.8 g, 76% and 23.3%, respectively. The plant of MI Raj-001 produced 70 fruits in this year. Maturity period of fruit was 2nd week of July. The fruit had very attractive yellowish maroon colour at ripen.

Evaluation of exotic mango germplazm

The experiment was conducted at the Regional Agricultural Research Station, Burirhut, Rangpur to find out a suitable mango germplasm. Six germplasm *viz*., MI Exo- Bur-001, MI Exo- Bur-002, MI Exo- Bur-003, MI Exo- Bur-004, MI Exo- Bur-005 and MI Exo- Bur-006 were evaluated . The germplasm was collected from local fruit fair and the saplings were planted in June 2018. The age of the tree was around 3 years and 1^{st} fruit bearing occurred in 2020.

Clonal selection of banana cv. Sabri

Seventeen Sabri banana germplasm (MS Isd-001, MS Isd-002, MS Isd-003, MS Isd-004, MS Isd-005, MS Isd-006, MS Isd-009, MS Isd-011, MS Isd-012, MS Isd-013, MS Isd-014, MS Isd-016, MS Isd-017, MS Isd-018, MS Isd-019, MS Isd-020 and MS Isd-021) were collected from Ishurdi region and planted at the Regional Agricultural Research Station, Ishurdi, Pabna to evaluate and identify the suitable lines. Maximum number of leaves was obtained from MS Isd-008 and MS ISd-009 (15) whereas MS Isd-015 produced minimum leaves (11). The highest bunch weight (22.95 kg) was found in MS Isd-009. MS Isd-002 produced the highest number of fingers per hand (19) whereas, MS Isd-020 got the lowest (14) fingers. However, the highest fruit yield (57.38 t/ha) was obtained from MS Isd-009 followed by MS Isd-002 (56.13 t/ha) and the lowest yield (30.75 t/ha) in MS Isd-012. MS Isd-002 exhibited the highest edible portion (82.05%). TSS contents ranged from 18.8 to21.8 (^{0} Brix).

Based on the results, it may be concluded that the accessions MS Isd-002, MS Isd-003, MS Isd-005, MS Isd-019, MS Isd-016 and MS Isd-048 performed better in terms of fruit yield and yield contributing characters.

Clonal selection of banana germplasm cv. Sabri at Jaintapur

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet with 4 'sabri kola germplasm (MS Jai-021, MS Jai-022, MS Jai-023 and MS Jai-024). A wide variation was observed regarding growth characteristics where MS Jai-021 was noted superior with plant height, base girth, leaf size and growth condition followed by MS Jai-024. Maximum bunch weight was obtained from MS Jai-024 (9.6 kg) while minimum bunch weight was recorded in MS Jai-021 (6.41 kg). Variation was also found in other characters. The highest hand weight (1.51 kg) and finger weight (90 g) were also found from MS Jai-024. Maximum yield was found in MS Jai-024 (46.86 t/ha) followed by MS Jai-024 (37.33 t/ha) while minimum (24.45 t/ha) yield was recorded in MS Jai-021. The highest TSS (24.5%) was recorded in MS Jai-024 while the lowest (18.0%) TSS was recorded in MS Jai-022. Number of hands per bunch was recorded maximum in MS Jai-024 (12) but number of fingers/hand was surprisingly higher in MS Jai-022 (20) compared to that of MS Jai-024 (13). Maximum finger size (11.8×3.5 cm^2) was recorded in MS Jai-024 while minimum (11.9×2.7 cm^2) finger size was recorded in MS Jai-022. Edible portion was observed maximumr in MS Jai-024 (88%).

Collection and evaluation of plantain germplasm

A field trial was conducted at RARS, Cumilla to study the performance of plantain germplasm. Five plantain germplasm, namely MP Cum-001, MP Cum-002, MP Cum-003, MP Cum-004, MP Cum-005 and BARI Kola-5 as check were used in the trial. Results revealed that maximum plant height (4.00 m) was observed in MP Cum-002 followed by MP Cum-003 (3.90) and it was minimum in BARI Kola-5 (3.76). The highest bunch length (85.00 cm) was recorded in lines MP Cum-002 and MP Cum-005 followed by MP Cum-001 (83.33 cm) and the lowest bunch length was recorded in BARI Kola-5 (62.00). The highest bunch breadth (131.67 cm) was recorded in MP Cum-002 which was statistically similar to those of others. Maximum bunch weight (18.23 kg) was recorded in lines MP Cum-003 while minimum brunch weight was recorded in BARI Kola-5 (12.30). Maximum peduncle weight (1.36 kg) and hand number (8.33) were recorded in MP Cum-001 which was statistically similar to those of others. Maximum weight (2.30 kg) of individual hand was recorded in MP Cum-003 and it was noted minimum in MP Cum-001 (1.46 kg). The highest finger number (12.33) was recorded in MP Cum-001 followed by MP Cum-005 and BARI Kola-5 (12.00). The highest finger length (19.30 cm) was recorded in MP Cum-002 which was statistically similar to those of others. The highest finger's diameter (5.70 cm), individual finger weight (245.13g), skin weight of individual finger (101.10 g), skin thickness (0.53 cm), edible portion weight per finger (152.13 g), edible portion % (62.67) and fruit yield (42.25 t/ha) were recorded in MP Cum-003 which was statistically different to those of others. Considering all the parameter, MP Cum-002, MP Cum-003, MP Cum-004 and MP Cum-005 were found promising and the most promising germplasm was MP Cum-003 and may put under further trial for final conclusion.

Hybridization in litchi

Hybridization in litchi was carried out at the Fruit Research Farm of HRC, BARI, Joydebpur, Gazipur during the flowering season of 2020 to incorporate some important characters like earliness, lateness, colour, regular heavy bearing habit in the desired variety or cultivar. Cross combinations for hybridization were: Kathali x BARI Litchi-2, BARI Litchi-2 x BARI Litchi-4, and Kathali x BARI Litchi-4. Initial fruit set was found 15, 12, 18 in Kathali x BARI Litchi-2, BARI Litchi-2 x BARI Litchi-4 and Kathali x BARI Litchi-4 cross combinations and finally number of fruits was harvested 0, 2, 0, respectively. From the cross combinations Kathali x BARI Litchi-2 and Kathali x BARI Litchi-4, the initial fruit set was recorded to be 15, 18 but unfortunately all the fruits dropped at the marble stage and finally no fruit was harvested. But from the cross between BARI Litchi-2 x BARI Litchi-4, 2 fruits were harvested and 2 seedlings have been raised, which will be planted in the main field.

Collection and evaluation of colour fleshed guava germplasm

Nine coloured guava germplasm *viz*. PG Joy-001, PG Joy-002, PG Joy-003, PG Joy-004, PG Joy-005, PG 006 PG Joy-007 PG Joy-008 and PG Joy-0093 were collected and planted at the Fruit Research Farm of HRC. BARI Joydebpur, Gazipur in July 2019. Performance of the germplasm were studied during 2019-20. Wide variation was observed in growth and yield contributing characteristics. The tallest plant was found in PG Joy-004 (1.88 m) and the shortest plant was recorded in PG Joy-007 (1.22 m). Maximum base girth was found in PG Joy-003 (9.33 cm) and minimum base girth was noted in PG Joy-008 (6.33 cm). Out of nine germplasm PG Joy-006 and PG Joy-007 did not bear fruit in this year. Fruit characteristics of 9 colour fleshed guava lines varied widely. The largest fruit was produced by PG Joy-002 (466.70 g). PG Joy-009 produced the smallest fruit (122.70 g). Maximum number of fruits/plant was recorded in PG Joy-001 (06)). The highest mesocarp TSS was found in PG Joy-002 (9.3%) and the lowest mesocarp thickness was demonstrated in PG Joy-005 (8%). Endocarp TSS was found maximum in PG Joy-002 (11.1%) minimum was in PG Joy-004 (7.2%).

Purification of Shahi papaya at Joydebpur

An experiment was carried out at the Fruit Research Farm of HRC, BARI, Joydebpur, Gazipur to purify the Shahi papaya variety during 2019-20. Seedlings of purified Sib-mated seeds were transplanted in the main field on the second week of March 2020 and the Sib-mating process (selfing of five flowers from each plant) for this year was started on 14 May 2020 and being continued. From May to July 2020, a total of 300 flowers were Sib-mated, among those flowers 267 fruits have been set. By comparing standard Shahi papaya characters and last 10 years experimental results, we the original Shahi papaya characters have almost regained and we need to maintain it through sib-matting every year to retrieve the original characters also to maintain the varietal purity.

Development of population for gynodioecious papaya variety

Development of gynodioecious population for obtaining 100% productive plants to increase farm income through papaya cultivation was performed at the Fruit Research Farm of Pomology Division under HRC, BARI, Gazipur during the period from the last week of December 2019 to till to date. Four sets of plants, namely S_6 progeny of CP Joy-005, CP Joy-009; BC_4 progeny and S_1 progeny of CP Joy-022 were included in the study. Among the four sets; S_6 progeny of CP Joy-005 produced 50, 43 and 7 percent andromonoecious, female and male plants, respectively; S_6 progeny of CP Joy-009 produced 52, 43 and 5 percent andromonoecious, female and male plants; the BC_4 progeny produced 58, 32 and 10 percent andromonoecious, female and male plants, respectively and S_1 progeny of CP Joy-022 produced 35, 43 and 22 percent andromonoecious, female and male plants, respectively. Considering the number of fruits/plants, 27, 24, 26 and 29 fruits were recorded in S_6 progenies of CP Joy-005 and CP Joy-009; BC_4 and finally S_1 progeny of CP Joy-022, respectively.

The results of the study revealed that, development of a gynodioecious papaya variety with 100% productive plant is about to finish.

Survey, collection and evaluation of papaya germplasm for papaya hybrid development (virus resistance and trait improvement)

An experiment was conducted at the research field of Pomology Division, HRC, BARI, Gazipur to evaluate the collected Papaya germplasm and varieties against PRSV and PMV as well as their fruit traits for variety development. In this study, sixteen Papaya germplasm (CP Joy-022, CP Joy-005, CP Joy-017, CP Joy-018, Jayantlady, CP Joy-025, CP Joy-009, CP Joy-003, Babu, CP Joy-023, Shahi pepe, Toplady, CP Joy-001, CP Joy-024, Badsha and CP Joy-026) were evaluated and found that the lines CP Joy-022, CP Joy-005, CP Joy-017, CP Joy-009, CP Joy-003, CP Joy-001, CP Joy-023 and Toplady showed complete resistance against PRSV and PMV. On the contrary, germplasm Jayantlady, Shahipepe, Babu, Badsha, CP Joy-024 and CP Joy-025 showed partial resistance, whereas higher disease incidence was observed in CP Joy-026. The complete resistant lines/varieties could be used to develop virus resistant variety considering other fruit traits in the future breeding program. Further evaluation is needed including more germplasm to show the efficacy of tolerance against PRSV and PMV.

Inter-specific hybridization in cultivated papaya

The study was conducted at the experimental field of Pomology Division, HRC, BARI, Gazipur to develop superior Papaya hybrids considering different qualitative and quantitative traits, which would fascinate the consumers demand and attention. In this study, 11 crossing combinations (Toplady x Shahipepe, Jayantlady x Shahipepe, Badsha x Shahi pepe, Shahipepe x Toplady, Shahipepe x Jayantlady, Shahipepe x Badsha, CP Joy-022 x Toplady, CP Joy-022 x Jayantlady, CP Joy-022 x Badsha, CP Joy-022 x CP Joy-024 and CP Joy-022 x CP Joy-025) were made among some popular variety and lines collected from different sources such as private company (Supreme Seed, ACI and Lalteer), farmer's field and our own germplasm, 42 flowers were emasculated and pollinated between Toplady x Shahipepe (6), Jayantlady x Shahipepe (7), Badsha x Shahipepe (3), Shahipepe x Toplady (4), Shahipepe x Jayantlady (5), Shahipepe x Badsha (5), CP Joy-022 x Toplady (2), CP Joy-022 x Jayantlady (3), CP Joy-022 x Badsha (2), CP Joy-022 x Pabna 2 (2) and CP Joy-022 x CP Joy-025 (3).

Heterosis breeding in papaya for PRSV tolerance

The experiment was conducted at the experimental field of Pomology Division, HRC, BARI, Gazipur to develop PRSV tolerant popular cultivar. In this study, line CP Joy-005, CP Joy-018, CP Joy-022 were used as pollen donor male parents since they possess higher level of PRSV tolerance and Shahipepe, Jayantlady, Toplady and CP Joy-005 were used as female parent for their higher commercial value and popularity. A total of 12 crossing combinations (CP Joy-005 x CP Joy-018, Jayantlady x CP Joy-005, Jayantlady x CP Joy-018, Jayantlady x CP Joy-022, Jayantlady x CP Joy-023, Toplady x CP Joy-005, Toplady x CP Joy-018, Toplady x CP Joy-022, Shahipepe x CP Joy-005, Shahipepe x CP Joy-018, Shahipepe x CP Joy-022 and Shahipepe x CP Joy-023) were made between the lines and cultivars. So far, 38 female flowers were emasculated and pollinated to incorporate the PRSV tolerance gene into Shahipepe, Jayantlady, Toplady and elite germplasm CP Joy-005. The newly developed F_1 hybrids will be further evaluated against PRSV to observe their effectiveness to PRSV tolerance in the following year, which would fascinate to develop virus resistant Papaya cultivars.

Evaluation of ber germplasm at Jamalpur

An experiment was conducted to identify suitable ber germplasm (*Zizyphus mauritiana*) at RARS, Jamalpur . Thirty nine germplasm (ZM Jam -122, ZM Jam -124, ZM Jam-127, ZM Jam -133, ZM Jam -140, ZM Jam -141, ZM Jam -143, ZM Jam -145, ZM Jam -151, ZM Jam -157, ZM Jam -169, ZM Jam -174, ZM Jam -175, ZM Jam -177, ZM Jam -178, ZM Jam -180, ZM Jam -182, ZM Jam -184, ZM Jam -185, ZM Jam -186, ZM Jam -187, ZM Jam -188, ZM Jam -193, ZM Jam -193, ZM Jam -194, ZM Jam -196, ZM Jam -198, ZM Jam -202, ZM Jam -205, ZM Jam -207, ZM Jam -214, ZM Jam -223, ZM Jam -225, ZM Jam -230, ZM Jam -231, ZM Jam -232, ZM Jam -239, ZM Jam -244 and ZM Jam -287) were included in the study. Wide range of variation was noted regarding quantitative and qualitative fruit characters. ZM Jam-124 had the maximum individual fruit weight 19.2 g and ZM Jam-143 got the minimum fruit weight 5.50 g . Yield per plant varied from 10 Kg ZM Jam-177 to 28 kg ZM Jam-287. Edible portion varied from 84.9 ZM Jam-225 to 95.3 % ZM Jam-207. Percent TSS varied from 13 ZM Jam-141 to 22 % ZM Jam-122 and ZM Jam-188.

Evaluation of existing ber germplasm at RARS, Akbarpur

An experiment was conducted to find out the suitable ber germplasm at the Regional Agricultural Research station, Akbarpur, Moulvibazar . Seventeen accessions were included in this study. Of them, two (ZM Akb-015 and ZM Akb-064) were harvested which showed diversified attributes regarding quantitative and qualitative fruit characters.Between this two germplasm ZM Akb-015 showed better fruit yield and quality.

Evaluation of indegenous ber germplasm at Khagrachari

A study was conducted at the Hill Agricultural Research Station, Khagrachari with nine (ZM Kha-005, ZM Kha-008, ZM Kha-013, ZM Kha-017, ZM Kha-021, ZM Kha-023, ZM Kha-024, ZM Kha-026 and ZM Kha-030) local ber genotypes . Average individual fruit weight ranged from 6.66 g to 17 g. The genotype ZM Kha-024 produced the highest individual fruit weight (17g) and the lowest value in ZM Kha-008 (6.66 g). Fruit weight of different ber genotypes ranged from 6.6-17.0 g. The genotype ZM Kha-024 produced the highest fruit weight (17.0 g) and the lowest fruit weight in ZM Kha-008 (6.6 g). Edible portion ranged from 68.4% in ZM Kha-021 to 92.0% in ZM Kha-026. TSS of ber genotypes varied from 9.2% in ZM Kha-030 to 18.4% in ZM Kha-017. Considering fruit characteristics, appearance, edible quality, harvesting period, TSS and percent edible portion the germplasm ZM Kha-023, ZM Kha-024, and ZM Kha-030 were found promising .

Collection and evaluation of sour type ber germplasm at Rajshahi

A study was conducted at the Fruit Research Station, Binodpur, Rajshahi with ton sour ber lines. Ten germplasm of ber were evaluated. Fruit weight was recorded the highest in ZM Raj-002 (11.07 g) followed by ZM Raj-005 (10.43 g) and ZM Raj-006 (10.43 g) whereas, the lowest fruit weight was observed (6.17 g) in ZM Raj-008. Total soluble solid (TSS) of different ber varied from 14.3-19.6 %. TSS was recorded the highest in ZM Raj-002 (19.6 %) followed by ZM Raj-010 (16.6 %). The highest edible portion was found in ZM Raj-002 (91.5 %) followed by ZM Raj-005 (89.2 %) and ZM Raj-006 (88.6 %). Fruit yield was recorded the highest in ZM Raj-002 (13.53 t/ha) and the lowest yield was recorded in ZM Raj-010 (10.40 t/ha). Among the ten sour type ber lines, ZM Raj-002, ZM Raj-005and ZM Raj-006 were found to be very promising for late season.

Collection and evaluation of local ber germplasm at Rajshahi

A study was conducted at the Fruit Research Station, Binodpur, Rajshahi with ten local and exotic ber varieties (Apple Kul, BARI Kul-1, BARI Kul-2, Chapai Kul, Local kul late, BARI Kul-3 and Umboli kul). Fruit weight was recorded the highest in BARI Kul-3 (38.8g) followed by BARI Kul-2 (34.5 g) whereas, the lowest fruit weight was observed in Umboli Kul (15.7 g). Total soluble solid (TSS) was recorded the highest in Umboly Kul-1 (17.3 %) followed by Apple Kul and BARI kul-1, while that was the lowest in BARI kul-2 (12.2%). BARI Kul-3 gave the highest yield (25.47 t/ha) and it was the lowest in Chapai Kul (10.92 t/ha). Among the other lines, Local Kul (Late) was found to be very promising for late season (upto Mid April).

Survey, collection and evaluation of jamun germplasm

An experiment was conducted at Fruit Research Station, BARI, Binodpur, Rajshahi to evaluate nine Jamun lines (SC Raj-001, SC Raj-002, SC Raj-004, SC Raj-005, SC Raj-006, SC Raj-013, SC Raj-014, SC Raj-015 and SC Raj-016) for superior traits (survey on different area in Rajshahi, Nator and Pabna). Wide variations were observed among the germplasm. The highest fruit weight of 15.0 g was obtained from SC Raj-014 followed by SC Raj-013 (13.0 g). Maximum edible portion (86.6 %) was obtained from SC Raj-014 and SC Raj-016 followed by SC Raj-005 and SC Raj-015 (85.0 %), whereas minimum edible portion (72.5%) was found in SC Raj-004. The highest TSS 18.0 % was obtained from SC Raj-013. Maximum yield/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 fruit yield, SC Raj-013 and SC Raj-014 were superior than other lines. This is third year experiment. So, this survey should be continued to collect superior germplasm.

Collection and evaluation of lemon germplasm

An experiment was conducted at the Agricultural Research Station, Cumilla to evaluate the superior lemon germplasm. Eleven germplasm of lemon (CLCum-002, CLCum-008, CLCum-012, CLCum-013, CLCum-014, CLCum-015, CLCum-016, CLCum-018, CLCum-019, CLCum-020 and CLCum-021) were included in this experiment. The highest number of fruits/plant (154) and weight of fruits/plant (16.94) were harvested in CL Cum-015 followed by CL Cum-008. The highest individual fruit weight (185.5 g) was recorded in CL Cum-014 followed by CL Cum-013.

Evaluation of exotic lemon germplasm

A lemon germplasm, planted at private nursery, Fatepur, Charghat, Rajshahi in 2008 which was collected from Greece. The germplasm was further collected and replanted at Fruit Research Station, Binodpur, Rajshahi in 2012 to compare its performance with BARI released and local existing lemon varieties. The plants were now seven years old. The plant height and base girth were observed 3.5 m and 30 cm, respectively. Number of primary branches was recorded 3. The plant produced 43 fruits. Growth condition of the genotype was good.

The plant growth and fruit characteristics were satisfactory. This was the fourth-year result. Further study is needed for final conclusion.

Collection and evaluation of lime germplasm

An experiment was conducted at the Agricultural Research Station, Cumilla to evaluate the superior lemon germplasm. Three lime germplasm (CA Cum-001, CA Cum-002 and CA Cum-003) were included in this experiment. The highest number of fruits/plant (300), weight of fruits/plant (14.90 kg) and individual fruit weight (49.67 g) was observed in CA Cum-001 followed by CA Cum-003.

Evaluation of lime germplasm at Jamalpur

The experiment was conducted at RARS, Jamalpur. Four lime (*Citrus limon*) germplasm *viz*., CL Jam-001, CL Jam-002, CL Jam-003 and CL Jam-004 were evaluated. There were differences among the germplasm studied regarding plant height, base girth, canopy spreading, number of branches/plant, number of fruits/plant, fruit length, fruit breadth, individual fruit weight, yield per plant and yield per hectaret. CL Jam-003 was found superior with the highest plant height of 2.20 m, large canopy size (2.50 m x 2.36 m) and number of branches (4.0). The highest number of fruits per plant was found in CL Jam-003 (77) followed by CL Jam-001 (34) and the lowest in CL Jam-004 (14). The highest individual fruit wt. was found in the line CL Jam-003 (62.2g) and the lowest from line CL Jam-002 (51.5g). The highest yield per plant was observed in the line CL Jam-003 (4.79 kg) and the lowest from CL Jam-004 (0.74 kg).

Evaluation of China mandarin germplasm in hill region

Forty germplasm of China Mandarin were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh. Plant height, base girth, number of main branch/plant, plant spread (N-S), plant spread (E-W) and number of fruit/plant range were 1.94-4.10 m; 13.0-18.0 cm; 1.0-3.0; 1.10-1.80 m; 0.99-1.92 m and 15-105, respectively.

In-situ evaluation of local mandarin lines under north-eastern hilly area of Bangladesh

The experiment was conducted to study the performance of mandarin germplasm at farmer's orchard and homestead in Jaintapur area of Sylhet. BARI Komala-1 was used as check. Seven superior mandarin germplasm (BARI Komala-1, CR Jai-202, CR Jai-203, CR Jai-204, CR Jai-205, CR Jai-206 and CR Jai-207) were evaluated. All the germplasm were found satisfactory considering growth parameters and yield as well as yield contributing characteristics. Among the germplasm maximum base girth (89.0 cm) was recorded in CR Jai-205 while minimum (46.6 cm) in BARI Komala-1. Plant height ranged from 3.25m to 6.70m. The tallest and the shortest germplasm were CR Jai-207 (6.70 m) and BARI Komala -1(3.25 m), respectively. The highest canopy size (5.61×6.20 m) was found in CR Jai 207 while the lowest (2.12×2.42 m) in BARI Komala-1. The heaviest fruit weight (190.45 g) was found in CR Jai-203 while the lightest(153.33 g) in CR Jai-207. Maximum number of fruits per plant (625) was recorded in CR Jai-206.. The highest yield per plant (97.45 kg) was obtained from CR Jai-203 whereas, the lowest (52.45 kg) in CR Jai-201. Maximum edible portion was observed in (72.69%) in CR Jai-203 while, the lowest (64.48%) in CR Jai-205. In case of total soluble solids (TSS) it was recorded the highest (13.6%) in CR Jai-203 and the lowest (10.3%) in CR Jai-201. Titratible acidity (TA) was also varied among the tested germplasm and the lowest TA (0.72%) was recorded in CR Jai-203 in contrast the highest (0.91%) in CR Jai-205.

Evaluation of mandarin germplasm under net house condition

The experiment was conducted at Citrus Research Station, BARI, Jaintapur, Sylhet. Six mandarin germplasm *viz*., CR Jai-011, CR Jai-013, CR Jai-014, CR Jai-015, CR Jai-016 and CR Jai-018 along with BARI Komala-3 as check were evaluated. The objective was to find out suitable germplasm with higher yield and quality, for farmers. A wide variation was observed in respect of yield and yield contributing characteristics. The highest number of fruits/plant (25) was found in CR Jai-018 and the highest yield per plant (4 kg) was found in CR Jai-015. Maximum fruit weight was found in CR Jai-015 (200.45 g) with the large fruit size (6.9×8.1 cm). No seeds were found in CR Jai-014. Edible portion was recorded maximum in CR Jai-015 (79.16%) and total soluble solids (TSS) was recorded the highest (13.8%) and titratible acidity (TA) was found the lowest in CR Jai-015 (0.72%). Fruit surface was found smooth in BARI Komala-3 and CR Jai-015 whereas others germplasm bore pitted skin. Strong adherence of albedo to pulp was found in CR Jai-014, whereas others were medium to weak. From the above results, the germplasm CR Jai-015 was found with large sized fruit (6.9×8.1 cm^2) with a maximum individual fruit weight (200.45 g) and a maximum yield (4 kg $plant^{-1}$). Moreover, maximum edible portion (79.16%) and TSS (13.8%) with lower titratible acidity (0.72%) was also found from CR Jai-015. Therefore, germplasm CR Jai-015 may be selected for releasing as a variety for farmers use.

Collection and evaluation of mandarin germplasm in Chattogram region

An experiment was conducted at the Agricultural Research Station, Pahartali in Chattogram for the evaluation of eleven mandarin genotypes *viz*., CR Pah-001, CR Pah-002, CR Pah-003, CR Pah-004, CR Pah-005, CR Pah-006, CR Pah-007, CR Pah-008, CR Pah-009, CR Pah-010, CR Pah-011(1), CR Pah-011(2), CR Pah-011(3) and CR Pah-011(4). The highest number of fruits was obtained from germplasm CR Pah-009 which was recorded as 65 followed by CR Pah-007 which was noted as 30. The lowest number of fruit was observed in germplasm CR Pah-004 (1.0) followed by CR Pah-001 (2.0). The entry CR Pah-007 performed superior over other lines in all aspects except TSS. Maximum TSS was found in the entry CR Pah-009 which was delicious in taste than those of other germplasm. Considering fruit yield and taste, CR Pah-009 and CR Pah-007 can be considered as superior mandarin lines for releasing as variety. Considering fruit yield and taste, CR Pah-009 and CR Pah-007 can be considered as promising mandarin line.

Evaluation of sweet orange germplasm in the hilly region

The experiment was conducted to study the performance of sweet orange germplasm collected from different locations of CHT and planted at HARS, Khagrachari. Two germplasm *viz*., CS Kha-001 and CS Kha-002 as compared with BARI Malta-1 as check variety to identify promising sweet orange germplasm in respect of fruit bearing, fruit quality and yield potentiality. Flowering time ranged from February to March in case of CS Kha-002 and BARI Malta-1 but in case of CS Kha-001 it was March. Harvesting time was late November in case of CS Kha 001. All the germplasm produced profuse fruits. No. of fruits/plant was the highest (209) in BARI Malta-1 while the lowest in CS Kha-002 (87). Individual fruit weight was also varying from 135.3-145.3 g. Weight of fruits/plant was the highest (27.53 kg) in BARI Malta-1, while CS Kha 001 produced 24.65 Kg/plant and the lowest (17.00 kg) in CS Kha-002. Number of seeds ranged from 10-22. Seed width ranges from 5.1-5.6 mm and seed length was ranged from 13.5-13.8. 100 seed weight observed lowest (9.0 g) in CS Kha -001 and the highest (14.4 g) in BARI Malta-1 where in case of CS Kha-002 it was found 9.1g. TSS ranged from 7.5 to 8.5 % Brix. Considering fruit characteristics i.e., taste, juiciness, sweetness, colour of pulp, fruit number and yield BARI Malta-1 was found excellent but in context of attractiveness, less incidence of insect-disease, considerable yield potentiality and edible qualities of CS Kha-001 was also found promising.

Collection and evaluation of variegated sweet orange genotypes in Chattogram region

An experiment was conducted at the Agricultural Research Station, Pahartali in Chattogram for the evaluation of eight sweet orange genotypes (CS Pah-001, CS Pah-002, CS Pah-003, CS Pah-004, CS Pah-005, CS Pah-006, CS Pah-007 and CS Pah-008). The highest number of fruits/plant (33) was attained from germplasm CS Pah-005 followed by CS Pah-003 and CS Pah-007 which is noted as 32. The highest fruit weight (261 g) was obtained from CS Pah- 009 followed by CS Pah-006 and CS Pah-007 which is noted as 247.5 g and 234.5 g respectively. The lowest fruit weight (172 g) was observed in CS Pah-001. The large and small fruit was found from CS Pah-009 and CS Pah-001, respectively. The lowest number of seed, the lowest seed weight was obtained from CS Pah-001. In the case of edible portion, the highest edible portion (64.1%) was found in CS Pah-004 and the lowest edible portion in CS Pah-002 (53.75 %). The highest TSS (13.8 %) was attained from CS Pah-001 followed by CS Pah-002 (11.6%). The lowest TSS was obtained from CS Pah-009 (7.15 %).

Based on fruit weight, TSS and other characters, CS Pah-001, CS Pah-002 and CS Pah-008 can be considered as superior germplasm of variegated sweet orange. It was first year observation. Evaluation will be needed to continue in the next years.

Performance of exotic sweet orange germplasm at Jaintapur

A study was conducted with four exotic sweet orange germplasm (CS Jai-003, CS Jai-012, CS Jai-051 and CS Jai-209) to evaluate their performances at Citrus Research Station, Jaintapur, Sylhet. BARI Malta-1 was used as check. Significant differences were recorded among the studied germplasm in terms of growth, yield and yield contributing characteristics. Maximum fruit weight (455 g) was recorded in CS Jai-051 while minimum (235 g) in BARI Malta-1. Fruit size also attained maximum (10.1×9.7 cm) in CS Jai-051. High juice content and the highest TSS (11 %) were recorded in CS Jai-003, while BARI Malta-1 attained the lowest TSS (9.7%). Edible portion was recorded maximum (79.12%) in CS Jai-051 which was followed by CS Jai 012 (77.37%), CS Jai-003 (75.87%) and BARI Malta-1 (73.83%). Fruit color at maturity of exotic sweet orange germplasm CS Jai-051, CS Jai-003, CS Jai-012, CS Jai-209 and BARI Malta-1were found pale green, bright yellow and greenish yellow respectively. Pulp colors of studied germplasm were found off white to orange, whereas BARI Malta-1was light yellow. Among the germplasm, CS Jai-003 and CS Jai-051 are promising and can be released as new sweet orange (Malta) variety. But final conclusion about these two varieties can be made after 2-3 years of further evaluation.

Evaluation of citron germplasm at Jaintapur

The experiment was conducted with four citron germplasm viz. CM Jai-059, CM Jai-060, CM Jai-061 and CM Jai-062 to study their performance at CRS, Jaintapur, Sylhet. The highest plant height (234.3 cm) and base girth (26.67 cm) were recorded in CM Jai-062. CM Jai-059 produces the large canopy size (112.67×143.0 cm) with the dense branches and good growth condition. CM Jai-062 had the shortest days to harvesting from flowering and matured by 118.7 days. Maximum number of fruits (31.67) was harvested from CM Jai-062 with maximum yield (26.32 kg/plant and 16.45 t/ha). In addition, CM Jai-062 bears relatively biggest fruits (831.2 g) with maximum peel thickness (27.13mm). Chemical analysis of fruits showed that CM Jai-062 had the highest albedo TSS (6.9%) and maximum edible portion (79.43%).

Evaluation of pummelo germplasm at Jamalpur

The experiment was conducted at HRC, RARS, Jamalpur. Five pummelo germplasm (CG Jam-001, CG Jam-002, CG Jam-003, CG Jam-004 and CG Jam-005) were evaluated in this study. A wide variation was observed in case of different plant growth and fruit characteristics of the Pummelo germplasm tested. CG Jam-001 was found superior with large canopy size (3.55 m x 4.28 m), highest tree volume, highest fruit number. The highest TSS (%) 4 was found in the line CG Jam-001. Considering growth and yield contributing characters it can be concluded that the line CG Jam-001 performed better.

Evaluation of pummelo germplasm in the hilly region of Rangamati

An experiment with seventeen germplasm of pummelo *viz*., CG Rai-006, CG Rai-007, CG Rai-008, CG Rai-009, CG Rai-010, CG Rai-011, CG Rai-014, CG Rai-017, CG Rai-020, CG Rai-021, CG Rai-025, CG Rai-028, CG Rai-030, CG Rai-047, CG Rai-048, CG Rai-052 and CG Rai-053 was conducted at the existing eleven 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 for the evaluation of superior pummelo lines in hilly region. Maximum number of fruits/plant (65) was observed in CG Rai-052 followed by CG Rai-008 (60), whereas the minimum (14) in CG Rai-011. The earliest flowering (mid February) was recorded in CG Rai-006 and the latest (mid March) in CG Rai-047. The heaviest individual fruit (1500g) was recorded in CG Rai-010 followed by CG Rai-011 (1400g). The highest edible portion (66%) also found in CG Rai-010. Maximum TSS (12.5%) was recorded in CG Rai-014. Quality fruit was observed in CG Rai-007, CG Rai-009, CG Rai-014, CG Rai-030 and CG Rai-047 by organoleptic test.

In-situ evaluation of year round pummelo germplasm at Khagrachari

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari. One off-season pummel at germplasm (CG Kha-001) was selected for the evaluation along with a normal season control. Mainly year round bearing occurred in the germplasm. Maximum numbers of mature (42) and immature (67) fruits were found in the month of September and May respectively. Average fruit weight was 1.35 kg. Maximum edible portion was obtained (50.91%) and the highest TSS (10.4%). The average number of fruits per month (17.67) was collected from CG Kha-001. Considering of fruit characteristics, edible quality, TSS, percent edible portion and yield potentialities, the germplasm CG Kha-001 was found promising.The number of fruits per month, fruit weight, edible portion (%) and TSS (%) were found satisfactory. Flesh of the line CG Kha-001 was soft, juicy, bitter less and very sweet in organoleptic test. Therefore, CG Kha-001 was found promising for year round cultivation of pummelo at the hilly

Evaluation of late season pummelo germplasm in the hilly region

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari during the year 2016-17, 2017-18 and 2018-19. One off-season/late season pummelo germplasm (CG Kha-001) was selected for the evaluation along with a check variety (BARI Batabilebu-5). It is late variety, harvesting time was December to January. CG Kha-001 was high yielder (107 fruits/plant and 154.1 kg/plant) in 12 year old plant compared to check variety (18.33 fruits/plant and 16.04 kg/plant). Fruits of the proposed line were pyriform shape, large in size and average individual fruit weight was 1450 g with excellent light yellow colour of rind where check variety produced less (875 g). Pulp was very sweet in taste, soft juicy, light pink in colour, having pleasant aroma and bitterness. Average edible portion was high (67.55%). Average TSS was comparatively high (9.30%) than check variety (9.05%). Fruit retention percentage was very high. Seeds were small in size (weight of 100 seed is 40.44 g). The germplasm (CG Kha 001) was less susceptible to insect- pests and diseases and plant could survive in drought condition.

In-situ evaluation of bael germplasm at Chapainawabganj

An experiment was evaluated at Chapainawabganj Sadar and Shibganj Upazila . The study comprised one bael germplasm. BARI Bael-1 was used as check. Age of the germplasm, AM Cha-001 was 32 years while BARI Bael-1 was 13 years. Maximum individual fruit weight (1172.5g) was found in AM Cha-001 while the minimum(800 g) in BARI Bael-1. Considering TSS (37), pulp percentage (72.23) and yield /plant (130 kg), the germplasm AM Cha-001 was found better. Considering TSS (37%), pulp percentage (72.2) and yield (130 kg/plant), the germplasm AM Cha-001 was found better. than that of BARI Bael-1.

Collection and evaluation of existing bael germplasm

An experiment was conducted to evaluate 22 bael genotypes (AM Cha- 001, AM Cha- 002, AM Cha-003. AM Cha- 004, AM Cha- 005, AM Cha- 007, AM Cha- 008, AM Cha- 009, AM Cha- 010, AM Cha- 011, AM Cha- 012, AM Cha- 013, AM Cha-014, AM Cha- 015, AM Cha- 016, AM Cha- 017, AM Cha- 018, AM Cha- 019, AM Cha- 020, AM Cha- 021 and AM Cha- 022) at the Regional Horticulture Research Station, Chapainawabganj to develop a bael variety for the commercial cultivation. Bael germplasm were collected from different places of Chapainawabganj and Rajshahi. A wide variation was observed among the genotypes regarding growth, fruit and tree characteristics. Only sixteen genotypes among 22 produced fruits for this year. Among the fruit characteristics, fruit weight varied from (306-2250 g), fruit length (8.5-16.2 cm), fruit breadth (8.2-16.5 cm), pulp weight (195.32-1749g), fibre weight

(8-350 g), seed weight (9-30.2 g) and TSS (26-38 %). Number of fruits per plant was recorded the highest in AM Cha-006 (65) and the lowest in AM Cha-010 (6). Considering over all assessment, 5 genotypes AM Cha-001, AM Cha-002, AMCha-006, AM Cha-016 and AM Cha-014 were found promising.

In-situ evaluation of bael germplasm at Jaintapur

The experiment was conducted at CRS, Jaintapur, Sylhet, during three consecutive years from 2017-18, 2018-19 and 2019-20. Four germplasm of bael *viz*., AM Jai-001, AM Jai-002, AM Jai-003 and AM Jai-004 were evaluated under this study. A wide variation was observed in case of different characters of the germplasm tested. Among the germplasm the highest number of fruits (135) was recorded in AM Jai-001 with maximum TSS (38.5%). The heaviest fruit was found in AM Jai-002 (1245.6g) with large sized ($15×12.7cm^2$) fruit. Maximum edible portion (83.6%) was recorded in AM Jai-001 while minimum (59.1%)was in AM Jai-004.

From the above study, germplasm AM Jai-001 was the best in terms of TSS , number of fruits/plant and edible portion.

Evaluation of bael genotypes at Burirhat

An experiment was conducted at the Regional Agricultural Research Station, Burirhat, Rangpur to develop high yielding variety of bael. Seventy two genotypes of bael were evaluated in this study. Out of 72 genotypes, 17 genotypes (AM Bur-001, AM Bur-002, AM Bur-011, AM Bur-012, AM Bur-013, AM Bur-014, AM Bur-027, AM Bur-028, AM Bur-029, AM Bur-031, AM Bur-032, AM Bur-037, AM Bur-038, AM Bur-039, AM Bur-043, AM Bur-044 and AM Bur-045) produced flowers and fruits during this season. Flowering time of different genotypes was observed in all the genotypes from 1st week of May to 4th week of May. Early flowering (1st week of May) was observed in the genotype AM Bur-012 and AM Bur-013 and late flowering (4th week of May) was observed in the genotype AM Bur-028 and AM Bur-037. Harvesting was done from 2nd week of March to 1st week of May. Maximum number of fruits per plant (35) was obtained from AM Bur-037, whereas minimum number of fruits (2) was found in AM Bur-014. The genotypes AM Bur-001 produced the highest fruit yield (29.00 kg/plant), while minimum fruits yield (0.84 kg/plant) was recorded in the germplasmAM Bur-014.

Study on the variability of bael germplasm in northern region of Bangladesh

An experiment was conducted at the Horticulture Research Farm, BSPC, Debiganj, Panchagarh to identify the superior bael germplasm. Wide variation was observed among the accessions in terms of morphological and yield contributing fruit characters. Plant height ranged from 6.35 m to 6.13 m, base girth ranged from 0.72 m to 0.63 m. Maximum canopy spread was measured in AM Deb-02 ($5.83×5.58$) m^2. Average number of fruit widely varied from 41 to 4.4 and AM Deb-03 was recorded the highest number 41 fruits per plant. The least fibrous and seeded germplasm was AM Deb-5. However, maximum pulp index was recorded in AM Deb-2 was 78.5 %. The percentage of rind portion ranged from 27.1 to 17.9 among the germplasm. Excellent flavor of fruit was noticed in the germplasm AM Deb-02 and AM Deb-05. Eating quality was good to excellent in most of the germplasm. Grittiness and bitterness was absent in those bael fruit. Maximum TSS was recorded in AM Deb-5 (40.4 %) followed by AM Deb-2 (35.5 %). Germplasm AM Deb-02 was identified as potential for varietal improvement program. Among the germplasm, number of fruits per plant, different qualitative quality, TSS the germplasm AM Deb-02 performed the best. The experiment will be continued.

Collection and evaluation of wood apple germplasm

An experiment was conducted at the Horticulture Research Farm, Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh to evaluate six wood apple germplasm. Among these germplasm only three germplasm, namely FL Deb-001, FL Deb-002, FL Deb-004 provided fruits and the remaining germplasm namely FL Deb-003, FL Deb-005, FL Deb-006 did not provide fruit. The highest number of fruits (41) was obtained from the germplasm FL Deb-002. The highest fresh fruit weight (295.6 g), ripe fruit weight (195.4 g), fruit length (7.4 cm), fruit diameter (7.1 cm), pulp weight (140.5 g), edible portion (71.9 %) and yield per plant (12.12 kg) were found in the germplasm FL Deb-002 than that of germplasm FL Deb-001 and FL Deb-004. The highest total soluble solids (16%) and the lowest rind weight (46.5 g), fiber weight (3.25 g) and rind thickness (3.67 mm) were found in the germplasm FL Deb-001.

Evaluation of wood apple in hilly area of Rangamati

An experiment on the evaluation of wood apple in the hill valley was conducted with four wood apple genotypes at the Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District. Four wood apple germplasm were evaluated. Plant height and base girth ranged from 370 cm to 640 cm and 56 cm to 88 cm, respectively. Number of fruits ranged from 79 to 198. Mean fruit weight was found to be 429 g. Edible portion ranged from 53.0 to 59.0%. Maximum fruit yield/plant was 90.1 kg and minimum was 31.9 kg.

Evaluation of golden apple germplasm in the hilly region

Four golden apple germplasm (SD Ram-001, SD Ram-002, SD Ram-003 and SD Ram-004) were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh. The line SD Ram-001 produced maximum number of fruits (4416/plant) and heavier fruit (101.3g/fruit) was produced also by the line SD Ram-001. Maximum fruit yield (446.1 kg /plant) was obtained from the same line SD Ram-001 and the lowest yield (179.8 kg/plant) was recorded in SD Ram-004. Considering fruit yield and yield contributing characters, SD Ram-001 was noted superior.

Evaluation of golden apple germplasm

The study was conducted at the Horticulture Research Field, RARS, Rahmatpur, Barishal to evaluate the performance of golden apple germplasm for releasing high yielding variety. Wide variations in growth characteristics among the accession were found. The tallest plant was observed in accession number SD Rah-05 (13.20 m) which was followed by SD Rah-04 (13.10 m). The heaviest fruit was harvested from SD Rah-04 (92.0 g) and the lightest fruit was obtained from SD Rah-05 (88.0 g). The highest number of fruit/plant was found in SD Rah-01 (692) followed by SD Rah-03 (646) and the lowest number was found in SD Rah-25 (512). The fruit yield/plant varied significantly and ranged from 45.06 kg to 72.52 kg. The accession SD Rah-01 produced the highest fruit yield (72.5 kg/plant) followed by accession SD Rah-03 (67.7 kg/plant). On the other hand, the lowest fruit yield was recorded in accession number SD Rah-05 (45.1 kg).

Collection and evaluation of lotkan germplasm

An experiment was conducted at the Fruit Research Farm of HRC, BARI, Joydebpur, Gazipur to know the performance of 10 collected germplasm of lotkan. The study comprised ten lotkan (*Baccaurea sapida*) germplasm to find out a suitable high yielding germplasm of lotkan. Out of 10 germplasm the highest plant height (6.33m), base girth (63cm), canopy spreading (N-S and E-W) (6.35x7.01m) were noted from BS Joy-010. Maximum individual fruit weight (22.3g) was found in BS Joy-004, while the minimum fruit weight (15.3g) was recorded in BS Joy-003. TSS (16.0%) was noticed maximum in BS Joy-004 and minimum TSS (15.3%) was recorded in BS Joy-006. Maximum edible portion (59.3%) was noted in the germplasm BS Joy-010 and minimum edible portion (40.8%) was recorded in the germplasm BS Joy-006. Maximum number of fruits (5842) and the highest yield (125.0 kg) were noticed in BS Joy-010 and minimum number of fruits and the lowest yield were noticed in BS Joy-007. Taste and eating quality of all the germplasm was auspicios.

In-situ evaluation of four burmese grape germplasm at Shibpur

An experiment was evaluated at Joynagar, Shibpur, Narsingdi. The study comprised four lotkan (*Baccaurea sapida*) germplasm to find out a suitable high yielding late germplasm of Burmese grape for releasing as variety. Out of four germplasm the highest plant height, base girth, canopy spreading (N-S and E-W) was noted from BS (N)-004. Maximum individual fruit weight (28.80 g) was found in BS (N)-001 while minimum fruit weight (20.10 g) was noted in BS (N)-004. The biggest fruit (3.58 x 4.09) was observed in BS (N)-001 and the smallest fruit was observed in BS

(N)-004. TSS (16.00%) was recorded maximum in BS (N)-002 and minimum TSS (14.7) was recorded in BS (N)-001. Maximum edible portion (63.02%) was noted in the germplasm BS (N)-004 and minimum edible portion (48.83%) was recorded in the germplasm BS (N)-002. Maximum number of fruits (8833.30) and highest yield (177.67kg) were noticed in BS (N)-004 and minimum number of fruits and lowest yield were noticed in BS (N)-001. Taste and eating quality of all the germplasm were excellent.

Evaluation of burmese grape germplasm at Jaintapur

The experiment was conducted to evaluate five Burmese grape germplasm *viz*., BS Jai-001, BS Jai-002, BS Jai-003, BS Jai-004 and BS Jai-005 at CRS, Jaintapur, Sylhet. A wide range of variation was observed in case of growth, fruit yield, yield contributing characters, and fruit quality of the studied germplasm. Among the germplasm, the tallest plant was recorded in BS Jai-005 (8.9 m) while the shortest was in BS Jai-004 (5.5 m). Base girth was found the highest in BS Jai-005 (1.5 m). Germplasm BS Jai-005 was also superior for the biggest canopy (12.0×13.0 m). The highest number of fruits/plant (2730), yield/plant (48.32 kg) and yield/ha (27.3t) were obtained from BS Jai-003. BS Jai-003 also free from disease whereas the other germplasm suffer from powdery mildew and sooty mould. Chaper beetle was common in case of all the germplasm but BS Jai-001and BS Jai-003 was free from fruit borer. The largest fruit was recorded in BS Jai-003 (3.2×3.5 cm) followed by BS Jai-001 (3.2×3 cm). Flesh color and texture for all germplasm was off white and juicy respectively. Maximum edible portion (35.0%) and per cent TSS (13.8%) was found in BS Jai-003.

In-situ evaluation and collection of superior burmese grape genotype

In-situ evaluation of Burmese grape was performed at the farmers field, Shibpur, Narsingdi with twelve Burmese grape germplasm (BS Nar-001, BS Nar-002, BS Nar-003, BS Nar-004, BS Nar-005, BS Nar-006, BS Nar-007, BS Nar-008, BS Nar-009, BS Nar-010, BS Nar-011 and BS Nar-012). Wide variation was observed in case of yield contributing characters, fruit yield and fruit quality of the germplasm studied. Maximum number of fruits/plant and yield/plant were obtained from BS Nar-006. BS Nar-005 and BS Nar-004. The heaviest (25.50 g) fruit was obtained from BS Nar-005, while the lightest (15.70 g) from BS Nar-011. Maximum edible portion was also recorded from BS Nar-005 (52.5 %) as compared to minimum in BS Nar-009 (32.7 %). Fruit size was the highest in BS Nar-006 (3.55 cm × 3.54 cm) followed by BS Nar-005 (3.46 cm × 3.64 cm). Flesh color and texture for all the germplasm was off white and juicy. Maximum edible portion (52.5%) and percent TSS maximum (17.2%) was noticed from BS Nar-005. Contemplating yield, edible portion and TSS, the germplasm BS Nar-005, BS Nar-006 and BS Nar-004 showed superior performance among the germplasm.

Collection and evaluation of aonla genotypes in Chattogram region

An experiment was conducted at Agricultural Research Station, Pahartali in Chattogram for the evaluation of ten aonla genotypes (EO Pah-001, EO Pah-002, EO Pah-003, EO Pah-004, EO Pah-005, EO Pah-006, EO Pah-007, EO Pah-008, EO Pah-009 and EO Pah-010). Among these ten genotypes only four were able to produce fruits. Maximum number of fruits were acquired from EO Pah-010 which was documented 674 followed by EO Pah-008 (180). The lowest number of fruits was observed in EO Pah-005. But TSS (18.75ºBrix) of this germplasm was surprisingly much higher than the other germplasm. The edible portion was also higher in EO Pah-005 (93.6). The maximum fruit length (3.65 cm) and fruit breadth (4.11 cm) was attained from EO Pah-010 and the minimum fruit length (2.65 cm) and fruit breadth (2.95 cm) were attained from EO Pah-005. EO Pah-010 ranked second in term of TSS (9.1ºBrix) and edible portion (92.8%).

Considering fruit yield, TSS, edible portion EO Pah-005 and EO Pah-010 can be considered as promising lines of aonla.

Evaluation of carambola germplasm

An experiment was conducted at the Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh to study the genetic diversity of carambola and to identify superior genotypes with desirable characters. The experimental result showed that individual fruit weight ranged from 52.4 g (AC Deb-009) to 128 g (AC Deb-014); fruit diameter 4.09 cm (AC Deb-009) to 6.48 cm (AC Deb-014); fruit length 6.95 cm (AC Deb-09) to 10.34 cm (AC Deb-014); number of fruits/plant in a season 233 (AC Deb-015) to 703 (AC Deb-014); fruit yield in a season 13.62 kg (AC Deb-009) to 89.98 kg/tree (AC Deb-014); and TSS 3.5 % (AC Deb-010) to 8.5% (AC Deb-013). The selected carambola genotypes exhibited noticeable variation in the morphological and yield contributing characters.

Collection and evaluation of bullock's heart germplasm

An experiment was conducted at the Horticulture Research Farm, Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh to evaluate two germplasm. The highest number of fruits (370) was obtained from germplasm AR Deb-002. The individual fruit weight, fruit length, fruit diameter, pulp weight, edible portion and Total soluble solids (TSS) was higher in germplasm AR Deb-001 than that of AR Deb-002. But germplasm AR Deb-002 produced the highest fruit yield (72.19 kg) compared to AR Deb-001 (20.88 kg). Considering individual fruit weight, fruit length, fruit diameter, edible portion and Total soluble solids (TSS) the germplasm AR Deb-001 can be considered as promising line.

Evaluation of bullock's heart germplasm at Jamalpur

Five bullock's heart germplasm such as AR Jam-001, AR Jam-002, AR Jam-003, AR Jam-004 and AR Jam-005 were evaluated at the Regional Agricultural Research Station, Jamalpur during the year 2019-20. The highest plant height (3.54 m) was recorded in AR Jam-003 and the lowest (2.67 m) plant height was recorded in AR Jam-004. Base girth was noted maximum (30.25 cm) in AR Jam-001 and minimum (24.50 cm) in AR Jam-002. The highest tree volume was observed in AR Jam-001 (11.17 m^3) and the lowest tree volume was recorded in AR Jam-002 (6.66 m^3).

Collection and evaluation of custard apple genotypes at Chapainawabganj

An experiment on collection and evaluation of some custard appel genotypes was conducted at the Regional Horticulture Research Station, Chapainawabganj. Sixteen genotypes (AR Cha-01, AR Cha-02, AR Cha-03, AR Cha-04, AR Cha-05, AR Cha-06, AR Cha-07, AR Cha-08, AR Cha-09, AR Cha-010, AR Cha-011, AR Cha-012, AR Cha-013, AR Cha-014, AR Cha-015 and AR Cha-016) were collected from five Upazilas of Chapainawabganj. Seeds were sown into seed bed and after germination all of the genotypes were transferred into main field between 2015 and 2016. None of the genotypes produced fruits for this year. So data on plant growth characters were recorded only.

Collection and evaluation of custard apple germplasm

Fruit characteristics of four custard apple germplasm were studied in the laboratory of Fruit Research Station, BARI, Binodpur, Rajshahi during. The result indicated that wide range of diversity existed in fruit weight, pulp weight, TSS content, pulp content and skin weight etc. The weight of a matured fruit varied from 120.5 g to 129.4 g. The highest fruit weight (129.4 g) was observed in AS Raj-001 followed by AS Raj-002 (122.6 g) and the lowest fruit weight was noted in AS Raj-004 (120.5 g). Maximum (60%) edible portion was measured in AS Raj-002. TSS varied from 23.3 to 24.3 but there was no significant difference in TSS among the lines.

The germplasm AS Raj-002 showed better performance on the basis of fruit weight, skin weight, number of seeds/fruit, edible portion and TSS value.

Collection and evaluation of Indian dillenia germplasm

A study was carried out at the Horticulture Research Center, Regional Agricultural Research Stationto to evaluate the Indian dillenia germplasm available in Jashore region. One promising germplasm was evaluated at the Horticulture Research Center, RARS, Jashore for developing variety. However, the germplasm was collected from Jashore region and planted in 2009. The recorded plant height of the genotype was 8.7 m and date of flowering was 25 May 2019. It produced 195 fruits in the third year. Individual fruit weight and fruit yield/plant were 507.87 g and

99.03 kg, respectively. Though, only one germplasm had been evaluated but this is an excellent germplasm in respect of yield and quality.

Evaluation of Indian dillenia germplasm in hilly region

Three Indian dillenia germplasm were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh. The line DI Ram-003 produced maximum number of fruits (542/plant) while heavier fruit (742.3 g/fruit) was produced by the line DI Ram-005. Maximum fruit yield (385.1 kg /plant) was obtained from the line DI Ram-005 and minimum fruit yield (102.7kg/plant) was recorded in DI Ram-002. Considering yield and yield contributing characters, the line DI Ram-005 was found superior.

Evaluation of Indian olive germplasm

Nine Indian olive germplasm *viz*. ES Akb-01, ES Akb-02, ES Akb-03, ES Akb-04, ES Akb-05, ES Akb-06, ES Akb-07, ES Akb-08 and ES Akb-09 were evaluated at the Regional Agricultural Research Station, Akbarpur, Moulvibazar. The highest number of fruits/plant (13800) was found in ES Akb-04. Considering the quantitative characteristics of fruits ES Akb-003 line was found much lucrative and larger in size than those of all other lines.

Collection and evaluation of pomegranate germplasm

Eleven germplasm *viz*., PG Joy-001, PG Joy-002, PG Joy-003, PG Joy-004, PG Joy-005, PG Joy-006, PG Joy-007, PG Joy-008, PG Joy-009,PG Joy-010 and PG Joy-011 were evaluated at the fruit research farm of HRC, BARI during April 2018. The results indicated wide range of variation in plant height, base girth, canopy spread in respect of E-W and N-S, and number of branch, time of flower emergence and fruit set. Maximum plant height was observed in PG Joy-001and PG Joy-007 (1.93 m) and minimum plant height was noted in PG Joy-010 (1.56 m). The highest base girth was observed in PG Joy-005 (15.4 cm) and the lowest (8.2 cm) base girth was noticed in PG Joy-008 and PG Joy-011. Horizontal spread in respect of E-W and N-S orientation were highest in PG Joy-003 (1.94 m and 1.83 m) and the lowest horizontal spread was recorded in PG Joy-010 (1.24.94 m and 1.26 m). Number of primary branch per plant was recorded maximum in PG Joy-001 (3.12) and minimum in PG Joy-005 (2.0). The highest number of fruits per plant was obtained from PG Joy-001 (3.6).

Collection and evaluation of some pomegranate germplasm

Fifteen germplasm of pomegranate *viz*., PG Cha-001, PG Cha-002, PG Cha-003, PG Cha-004, PG Cha-005, PG Cha-006, PG Cha-007, PG Cha-008, PG Cha-009, PG Cha-010, PG Cha-011, PG Cha-012, PG Cha-013, PG Cha-014 and PG Cha-015 were evaluated for their performance at RHRS, Chapai Nawabganj. Flowering was occurred mid-March in PG Cha-002, PG Cha-004 and PG Cha-008 though flowering of remaining germplasm was in mid-April. The highest number of fruits (22) was recorded in PG Cha-004 followed by PG Cha-002 (15) whereas the lowest number of fruits per plant (00) was produced in PG Cha-001 followed by PG Cha-008(2), & PG Cha-012(2).The fruits were harvested from only two germplasm due to fruits were found rotten in others germplasm. PG Cha-004 showed the better considering Fruit weight (245 g), edible portion (53%) and TSS (15%) between the two germplasm.

Collection and evaluation of cowa germplasm

An experiment was conducted at RARS, BARI, Rahmatpur, Barishal to find out superior cowa germplasm. Eleven cowa germplasm viz. GC Rah-01, GC Rah-02, GC Rah 03, GC Rah-04, GC Rah-05, GC Rah-06, GC Rah-07, GC Rah-08, GC Rah-09, GC Rah-10 and GC Rah-11 were included. Wide variations in growth characteristics among the germplasm were found. Among the germplasm, the highest plant height was attained in GC Rah-07 (498 cm) and the lowest one was in GC Rah-10 (240 cm). The highest number of fruits/plant was found in the germplasm GC Rah-03 (1600) and the lowest number of fruits/plant was found in GC Rah-11 (270). The highest individual fruit weight was found in GC Rah-03 (45.75 g) and the lowest fruit weight was noticed in GC Rah-02 (32.50 g). The highest yield was found in GC Rah-03 (73.20 kg/plant) and the lowest yield was recorded in GC Rah-11 (9.59 kg/plant).

Collection and evaluation of cowa germplasm

Three cowa germplasm *viz.* GC Leb-01, GC Leb-02, GC Leb-03 were evaluated at the RHRS, Lebukhali, Dumki, Patuakhali. Wide variations among the germplasm were found. The highest plant height was attained in GC Leb-01(125cm) and the lowest plant height was observed in GC Leb-03 (110 cm). The highest total number of fruits per plant was found in the germplasm GC Leb-02 (70) and the lowest fruit was noted in GC Leb-03 (40). The highest individual fruit weight was found in the germplasm GC Leb-02 (81.15 g) and the smallest fruit weight was demonstrated in GC Leb-03 (35.0 g). The largest fruit was found in GC Leb-02 (6 x 4.95 cm) and the smallest fruit was noticed in GC Leb-03 (3.90 x 4.20 cm). Maximum fruit yield per plant was recorded in CG Leb- 02 (5.68 kg).

Evaluation of phalsa germplasm

One germplasm of Phalsa (GA Raj-001) was evaluated at Fruit Research Station, BARI, Binodpur, Rajshahi. Germplasm (GA Raj-001) was a small spreading tree having plant height 10.5 m and base girth 1.3 m. The yellow flowers were born in dense cymes in the leaf axils during March to May. The fruit was round, drupe and dark purple in colour when ripe. The flesh color was light greenish white. The length and breadth of the fruit were 1.3 cm and 1.2 cm, respectively. Length of peduncle was 2.5 cm. Fruit flavor was slightly astringent. Weight of 100 fruits, seed and flesh was 72.5 g, 8.2 g and 53 g, respectively. The edible portion and TSS was 71% and 27.6%, respectively. Number of seeds per fruit was 1-2 and opaque type, brown, round or hemispherical seed showed low seed shattering tendency.

Evaluation of phalsa in hilly area of Rangamati

An experiment was conducted to evaluate phalsa germplasm at the minor fruits orchard in hill valley of Hill Agricultural Research Station, Raikhali, Rangamati. Four germplasm viz., GA Rai-001, GA Rai-002, GA Rai-003 and GA Rai-004 were included in this experiment. Maximum fruit yield/plant (8.7 kg), fruit length (9.21 mm), TSS (24.6 %) and fruit yield (3.6 t/ha) was found in the genotype GA Rai-002, on the other hand the highest 100 fruit weight (61.1 g) was measured in the genotype GA Rai-003.

Evaluation of jaboticaba germplasm in hilly region

Five germplasm of jaboticaba fruits viz., EC Ram-001, EC Ram-002, EC Ram-003, EC Ram-004 and EC Ram-005 were evaluated at the Hill Tracts Agricultural Research Station, Ramgarh, Khagrachari. Maximum number of fruits (770/plant) was found in EC Ram-002 and weight of fruits (4.58 kg/plant) was harvested from the same germplasm and TSS was also recorded the highest (11.92%) in EC Ram-004.

Evaluation of water chesnut germplasm

Three water chestnut (*Trapa bispinosa* Roxb) germplasm *viz.*, TB Jam-001, TB Jam-002and TB Jam-003 were evaluated at the Regional Agricultural Research Station, Jamalpur. The highest stem length (2.40 m), leaf length (5.61 cm), leaf breadth (7.53 cm), petiole length (12.45 cm), individual fruit weight (18.0 g), and pulp wt. (7.9 g) were recorded in TB Jam-001 and the lowest in TB Jam-003. The highest yield per hectare (90.8 t) was observed in TB Jam-001 and the lowest (82.6 t) in TB Jam-003.

Evaluation of dragon fruit germplasm

The study was conducted at Citrus Research Station (CRS), Jaintapur, Sylhet with three germplasm of dragon fruit viz., HC Joy-001, HU Jai-002 and HM Jai-003 during 2018-19. Number of side branches was found maximum (19) in HU Jai- 002 and minimum (15) in HC Jai-001. Flowering duration was recorded from 24 May to 28 May between the germplasm. The highest number of fruits was obtained from HU Joy-002 (21). HU Jai-002 produces the largest fruit (397g) with maximum (81.11%) edible portion.

Evaluation of avocado germplasm

A study was carried out at the Fruit Research Farm of Horticulture Research Center, BARI, Gazipur during 2018-19 to evaluate the avocado germplasm. Seven germplasm *viz*., PA Joy-001, PA Joy-002, PA Joy-003, PA Joy-004, PA Joy-005, PA Joy-006 and PA joy-007 were evaluated in this study. Vegetative growth, flowering time and number of fruit set of avocado were studied. Growth of all the germplasm was noticed satisfactory. Plant height of the studied germplasm ranged from 1.75 to 7.10 m having an average height of 3.73 m and a base girth of 33.71 cm. Out of seven germplasm only three, namely PA Joy-003, PA Joy-004 and PAJoy-006 produced flower from late January to first week of February. Finally, two germplasm PA Joy-003 and PA Joy-006 produced 4 and 11 fruits, respectively.

Characterization of oils extracted from the pulp of avocado fruits

A study was carried out at the Fruit Research Farm of Horticulture Research Center, BARI, Gazipur to evaluate the two avocado germplasm. BARI Avocado-1 and PA Joy-001 were included in this study. Data on TSS, P^H value, Vitamin-C, Total sugar and β-carotene content of avocado were studied. BARI Avocado-1 produced maximum β-carotene (54.29 µg/100 g) and TSS (11.40%). Vitamin C content was also two folds higher (7.06 mg/100 g) in BARI Avocado-1 than the accession PA Joy-001 (3.53 mg/100 g).

Collection and evaluation of peach fruit germplasm

A study was conducted at the Horticulture Research Farm, Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh to evaluate the growth, flowering and fruiting behavior of three peach fruit germplasm. Three germplasm *viz*., PP Deb-001, PP Deb-002 and PP deb-003 were included in this experiment. Data on the plant growth and fruit characteristics plant height, base girth, canopy spread, days of flowering, days to full bloom (when 80% flowers open), days of fruit set and harvest of fruit (tree-ripe stage), fruit length and diameter, fruit weight, pulp weight, peel weight, fruit thickness, total soluble solids (TSS), edible portion, yield per plant seed characteristics of peach fruit germplasm were recorded. The highest individual fruit weight (84 g), fruit length (6.3 cm), fruit diameter (5.25 cm), pulp weight (68.5 g), total soluble solids (TSS) percentages 11.57 and maximum yield per plant (200 kg) was found in PP Deb-001 germplasm. Maximum edible portion (82.81 %) was found in the germplasm PP Deb-003. The lowest peel weight (7 g), fruit thickness (1.6 cm) and seed weight (4 g) was found in PP Deb-003 germplasm.

Collection and evaluation of european plum germplasm in Chattogram region

An experiment was conducted at the Agricultural Research Station, Pahartali in Chattogram for the evaluation of European plum genotypes. There were four European plum genotypes *viz*. PD Pah-001, PD Pah-002, PD Pah-005 and PD Pah-006. The highest number of fruits was obtained from germplasm PD Pah-002 which is recorded as 79 followed by PD Pah-006 which was noted as 64. The lowest number of fruit was found in germplasm PD Pah-005 (07). The fruits of PD Pah-005 and PD Pah-006 were drop out during maturity stage. The individual weight, fruit length, fruit breadth, seed length and seed breadth, edible portion and TSS were more in PD Pah-001 than PD Pah-002. Considering individual fruit weight, fruit length, fruit breadth, seed length and seed breadth, TSS and edible portion PD Pah-001 can be considered as promising line.

Project: Propagation technique

Effect of time of grafting on BARI developed jackfruit varieties

An experiment was conducted at the Fruit Research Farm, HRC, BARI, Joydebpur, Gazipur to study the effects of time and variety on the grafting success of jackfruit. There were two factors in the experiment *viz*., time of grafting (February, March, April, May, June, July, August, September, October, November, December and January) and variety of jackfruit (BARI Kanthal-1 and BARI Kanthal-2). Time of grafting and variety alone and in combination influenced the success of grafting and days required to sprouting. The highest grafting success (78.2%) was recorded in January grafting with BARI Kanthal-1 followed by that of January grafting with BARI Kanthal-2 (76.8%).

Manipulation through grafting & pruning for dwarf shape of BARI released mango variety

A study on manipulation through grafting & pruning for dwarf shape of BARI released mango variety was conducted at RHRS, Chapainaawabganj. The experiment was laid out in RCB design with three replications with having 4 m X 5 m plant spacing. The experiment comprised of seven treatments. The following treatments were used: T_1 = Control (Normal grafting), T_2 = single grafting at the height of 5 inch, T_3 = Double grafting at the height of 5 inch interval, T_4 = Triple grafting at the height of 5 inch interval,T_5 = single grafting at the height of 5 inch + Cutting main stem 5 inch above grafting,T_6= Double grafting at the height of 5 inch interval + Cutting main stem 5 inch above grafting,T_7 = Triple grafting at the height of 5 inch interval + Cutting main stem 5 inch above grafting. The first grafting in all treatments was done in 29 May, 2018. Second grafting was done in the four treatments in 29 May, 2019. This year, Triple grafting was done in the two treatments (T_4 & T_7) in 20 May, 2020. Among the remaining five treatments, Cutting main stem 5 inch above grafting was done this year in the treatment T_6 while cutting main stem 5 inch above grafting was done this year in the treatment T_5 last year.

In- vitro propagation of guava

The study was undertaken to develop a suitable and reproducible protocol for *in-vitro* propagation of guava *(Psidium guajava* L.*)*. Five treatments *viz*., T_1 (0), T_2 (0.5 mg/l), T_3 (1.0 mg/l), T_4 (1.5 mg/l) and T_5 (2.0 mg/l) were included in this study. Shoot tips from healthy and disease free plants of BARI Peyara-2 were used as explant and cultured on MS media supplemented with different concentration of BAP and Kinetin along with a control. The response of the explant varies with different concentration of plant growth regulators. MS media supplemented with BAP performed better than Kinetin in all parameters. However, the highest survival percentage (96 %) of explant were found in T_2 treatment i.e. MS media supplemented with BAP at 0.5 mgL^{-1} and the maximum number (5) of explant turns into greenish color in T_2 followed by T_3 (3) and T_4 (3) treatments of BAP.

Micro propagation in papaya

For the development of a suitable and reproducible protocol for micro propagation of papaya, shoot tips of BARI papey-1 were cultured on MS medium supplemented with different concentrations of BAP with 4% sugar. The types of responses were varied at different concentrations of BAP. Among the treatments, BAP at 3.0 mg/l (T_4) and 2.0 mg/l (T_2) were found better for shoot induction of the explants.

Effect of rootstocks on growth, yield and quality of sweet orange

Considering the beneficial effect of rootstock on productivity, quality and longevity of scion varieties, a rootstock trial was conducted at the Fruit Research Farm of HRC, BARI, Gazipur to evaluate the growth, flowering and fruiting behavior of BARI Malta-1. The scion of BARI Malta-1 was taken from single elite mother plant and grafted on five different rootstocks *viz*., Pummelo, Rough lemon, Rangpur lime, Kalamansi and sweet orange. Data on the plant and fruit characteristics of BARI Malta-1were recorded. The longest plant (235.8 cm) and maximum tree volume (1.77 m3) was recorded on the graft produced on pummelo rootstock and shortest plant (135.0 cm) and minimum tree volume (0.39 m3) was recorded on rootstock sweet orange. Maximum fruit/plant (26.2) was noted on the graft produced on pummelo rootstock and minimum (7.8) on kalamansi rootstock. Maximum TSS (9 %) with less juice content (28 %) was recorded in the plant grafted on sweet orange root stock where as moderate TSS (7.5 %) with maximum juice content (36 %) recorded in the plant grafted on pummelo root stock.

Effect of rootstocks on the performance of BARI Malta-1

A study was conducted at Citrus Research Station (CRS), Jaintapur, Sylhet to study the performance of BARI Malta-1 using six citrus rootstocks *viz*., pummelo, sweet orange (BARI Malta-1), deciber (CS Jai-001), sweet lime, rough lemon and karun jamir. Significant variation was observed in first year observation in different vegetative characters. The highest plant height was recorded in sweet lime rootstock (210.33 cm) followed by rough lemon (183 cm) whereas the lowest was found in sweet orange (168 cm). Maximum base girth was found in rough lemon rootstock (17.67 cm) followed by pummelo (17 cm) whereas minimum in deciber and karun jamir rootstock (11.67 cm). Plant canopy was recorded the highest in rough lemon rootstock (149.67×153 cm) while the lowest in deciber rootstock (91×88.67 cm). Results of one successive years of investigation revealed that rough lemon rootstock exhibited excellent growth condition whereas poorest performance was in deciber rootstock.

Effect of different rootstocks on the growth and yield of BARI Satkara-1

A study was conducted at Citrus Research Station (CRS), Jaintapur, Sylhet to evaluate the performance of using different citrus rootstocks *viz*., pummelo, Rangpur lime and rough lemon. Significant variation was observed in first year observation and the highest plant height (3.35 m) was recorded in plant grafted on to pummelo rootstock followed by rough lemon (2.53 cm) whereas lowest (2.25 cm) was found in Rangpur lime rootstock. Maximum base girth (23.33 cm) was found in Rangpur lime whereas minimum (16.67cm) in rough lemon rootstock. Plant canopy was recorded the highest (2.2 ×2.6 cm) in pummelo rootstock. In first year observation plants of BARI Satkara-1 grafted on to Rough lemon rootstock exhibited excellent growth condition.

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 to observe the performance of grafted and seedling plants of velvet apple var. BARI Bilati Gab-1. There were two types of plants *viz*. grafted and seedling plant and these plants were planted in June, 2010. Average plant height varied from 2.70 m to 5.14 m, and number of branches/plant (9.1), base girth (20.5 cm) were found from grafted plant. In case of seedling plant, number of branches/plant (7.5), base girths (27.1 cm) were recorded. The higher number of fruits (32.3/plant) was obtained from grafted plant compared to seedling plant (16.7/plant). Yield was also higher (6.03 kg/plant) in grafted plants compared to seedling plants (3.14 kg/plant).

Split application of fertilizer for young grafted jackfruit plant

An experiment was conducted at the Fruit Research Farm of HRC, BARI, Joydebpur, Gazipur to study the effects of split application of fertilizer on young grafted plant of BARI Kanthal-3. There were five fertilizer practices ; total amount of N and K fertilizers applied 2 times at May and September; 4 times at May, August, November and February ; 6 times at May, July, September, November, January and March; NPK fertilizers 6 times at May, July, September, November, January and March and control (only cowdung). Data on growth characters like plant height, base girth and plant spreading of grafted jackfruit plant were recorded. Grafted jackfruit plants are in growing condition. Higher growth and development were observed in plants treated with N and K 6 times as well as N, P and K 6 times.

Project: Cultural management

Growth, yield and quality of mango as influenced by fertilizer and irrigation

Influence of fertilizer and irrigation on the yield and quality of mango was studied at the Fruit Research Farm of HRC, BARI, Joydebpur, Gazipur. Three different 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. Number of fruit set per panicle and number of fruits at harvest were noticed the highest in the treatments 250 % (27.2) and 175 % (0.90) of the fertilizer dose, respectively. Control plants always exhibited minimum number of fruits per panicle. Fruits from all the treatments were harvested on 24 July 2020. Maximum number of fruits (170.04) and yield (69.31 kg) per plant were recorded from the plants treated with 250 % of the fertilizer dose combined with irrigations at an interval of 10 days and 175% of the fertilizer doses plus irrigation 10 days interval up to maturity, respectively as compared to minimum fruits and yield (130/plant and 52.37 kg/plant, respectively) in the treatment combination of no fertilizer and two irrigations one at flowering stage and another one at pea stage of fruit. Maximum individual fruit weight (437.7 g) was observed in the plants treated with 175 % of the fertilizer dose in combination with two irrigations one at flowering stage and another one at pea stage of fruit. Fertilizer at 175% combined with two irrigations resulted in higher TSS (17.9%).

Organic production of mango

A study with three organic fertilizers i.e. vermicompost, tricocompost and cowdung along with the control (no fertilizer) was performed in order to produce safe and quality fruit at the Fruit Research Farm of HRC, BARI, Gazipur. In the vegetative characters, no significant variations were noticed with respect to canopy spread (N-S), length panicle, number of secondary branch per panicle but plant height, canopy spread (E-W), length of terminal shoot and number of leaves per terminal shoot differed significantly due to organic treatments. Vegetative growth was more in the treatment vermicompost compared to other treatments. Though number of panicles per plant and number of fruit set per panicle on 15.03.19 were recorded maximum (313.7 and 31.1, respectively) in tricocompost, vermicompost treated plants gave higher number of fruits per panicle (0.9) which was identical to all other treatments, except control during harvest on 22.07.19. Vermicompost produced higher number of fruits (249.0), bigger fruits (420.7 g) and maximum yield (104.9 kg) per plant. Superiority was observed with respect to edible portion (79.6 %) in tricocompost. TSS was noticed maximum in vermicompost (18.3%). Irrespective of kinds, organic fertilizers performed well in terms of number of fruits, fruit weight as well as yield and other traits over control.

Effect of canopy management on growth and yield of mango

The experiment was undertaken at the Fruit Farm of HRC, BARI, Joydebpur, Gazipur with BARI Mango-3, BARI Mango-4 and BARI Mango-8 to standardize canopy architecture of mango plants planted at closer spacing. The experiment was set following a Randomized Complete Block Design with 5 replications. Immediately after fruit harvest of previous season the 8 years old plants of BARI Mango-3, BARI Mango-4 and BARI Mango-8 were pruned by 50 cm from the tip. Adequate care and management of the plants in the experiment were taken as per requirement. Maximum canopy spread (375 cm and 348 cm, respectively) as well as tree volume (55.55 m^3) was recorded in BARI Mango-8 and minimum canopy dimension was noticed in BARI Mango-3. Maximum number of fruits per plant (68.80) was recorded in BARI Mango-8 and minimum number of fruits per plant (45.60) was counted in BARI Mango-4. The highest individual fruit weight was measured in BARI Mango-4 (372.0 g) which was followed by BARI Mango-8 (256.8 g) and the lowest individual fruit weight was observed in BARI Mango-3 (158.2 g). BARI Mango-8 yielded maximum (17.65 kg/plant) among the three varieties. Statistically similar yield was recorded in BARI Mango-4 (16.96 kg/plant). The relation between the yield and the tree volume indicates that tree size management by tip pruning can give higher yield from per unit area of a closer spaced mango orchard. Thus, pruning at appropriate level could be one of the most important tools of structuring mango orchard to a desired canopy architecture as well as yield.

Effect of bagging and fruit thinning on the yield and quality of mango

The study was carried out at the HRC Fruit Orchard, RARS, Jamalpur during the season of 2019 to study the effect of bagging and fruit thinning on the yield and quality of BARI Aam-3. The treatments were: Factor-A: Fruit thinning (04) viz; 15%, 30%, 45% and Control, Factor-B: Bagging (03) viz., Single layer white bag, Double Layer brown bag and Control. In consideration of effect of fruit thinning and fruit bagging in terms of yield contributing characters of BARI Aam-3, 45 % fruit thinning and fruit bagged with double layer brown bag produced heaviest fruit (195.33 g) , maximum edible portion (76.72%), more shelf life , low incidence of diseases and no insect infestation. Fruit size was increased by all type of thinning than control. Attractive fruit colour develped with both type of bagging.

Effect of integrated fertilizer management on growth and yield of mango (CV. Harivanga)

An experiment was conducted at Khoragach, Mithapukur, Rangpur under Regional Agricultural Research Station, Burirhat, Rangpur with a view to find out optimum doses of organic and inorganic fertilizer. Six levels of fertilizer were used in the experiment. Fertilizer levels were T_1 (Control), T_2(Cowdung 15kg+Urea 300g+ TSP150g+MoP 50g+Zypsum50g+ZnSo$_4$ 5g+Boron 15g), T_3(Cowdung 20kg+Urea 350g+ TSP 200g+MoP 100g+Zypsum100g+ZnSo$_4$ 10g+Boron 20g), T_4(Cowdung 25kg+Urea 400g+ TSP 250g+MoP 150g+Zypsum150g+ZnSo$_4$ 15g+Boron 25g), T_5(Cowdung 30kg+Urea 450g+ TSP 300g+MoP 200g+Zypsum200g+ZnSo$_4$ 20g+Boron 30g) and T_6(Cowdung 35kg+Urea 500g+ TSP 350g+MoP 250g+Zypsum250g+ZnSo$_4$ 25g+Boron 35g).The maximum number of fruits per plant (290) was obtained from T_4 (Cowdung 25kg+Urea 400g+ TSP 250g+MoP 150g+Zypsum150g+ZnSo$_4$ 15g+Boron 25g),which was statistically similar with T_6 (Cowdung 35kg+Urea 500g+ TSP 350g+MoP 250g+Zypsum250g+ZnSo$_4$ 25g+Boron 35g) and T_3(Cowdung 20kg+Urea 350g+ TSP 200g+MoP 100g+Zypsum100g+ZnSo$_4$ 10g+Boron 20g), whereas minimum number of fruits (50) was found in T_1(Control) treatment. The highest fruit yield (71.12kg) per plant was recorded from T_4(Cowdung 25kg+Urea 400g+ TSP 250g+MoP 150g+Zypsum150g+ZnSo$_4$ 15g+Boron 25g), which was at par(65.44kg) with T_3(Cowdung 20kg+Urea 350g+ TSP 200g+MoP 100g+Zypsum100g+ZnSo$_4$ 10g+Boron 20g) and T_6(Cowdung 35kg+Urea 500g+ TSP 350g+MoP 250g+Zypsum250g+ZnSo$_4$ 25g+Boron 35g), while the lowest (45.44kg) yield of fruits was found in T_1(Control) treatment.

Study on the pollen viability of litchi during preservation

An experiment was carried out at the Pomology Division, Horticulture Research Center, BARI, Gazipur owing to study the pollen viability of litchi during storage. Male flowers of BARI Litchu-2 were collected at anther dehiscence stage; time between 8 and 10 a.m. Collected pollens were stored at 5 different storage conditions such as; at room temperature (25-30^{0}C) in petridish, at room temperature in desiccator, refrigerator (5-7^{0}C) , deep freeze (-20±2^{0}C) and -80^{0}C Deep freeze . Fresh pollen showed 45.42% viability, which had 27.47% viability after 7 days of storage in petridish. After 7 days of storage, 33.32% viable pollen was noticed when pollen was stored in desiccator at ambient temperature. Pollen viability under refrigerated condition lasted up to 60 days and it was observed 26.07%. At deep freeze (-20±2^{0}C) condition, pollen remained viable up to 60 days, which was 34.02%. Pollen viability was tested through in-vitro germination for all the storage conditions. Pollen stored in Deep freeze remained viable up to 60 days, which exhibited 26.60% germination at the same condition.

Effect of bagging on the fruit quality of litchi

Different bagging materials viz. perforated polythene bag (T_1), brown paper bag (T_2), white paper bag(T_3), mosquito net bag(T_4) along with control (T_5) were used for controlling litchi fruit borer infestation in the variety BARI Litchu-2 at RARS, Akbarpur during April to June, 2020. All the bagging materials gave protection against the fruit borer infestation over control. The maximum fruit borer infestation (30.21%) was recorded in control while minimum (3.43%) was found in the brown paper bag. The highest fruit weight (19.30g) and the highest percentage of TSS (16.65%) were also found in the same treatment. Considering the fruit borer infestation, weight of fruit, size of fruit, aril weight and %TSS, among the four bagging techniques, bagging of litchi fruits with brown paper bag was found the best for the control of litchi fruit borer.

Effect of organic and inorganic fertilizers with different spacings on yield and quality attributes of guava

An experiment was carried out at the Fruit Research Farm of HRC, BARI, Gazipur in order to evaluate the effect of organic and inorganic fertilizer with different spacings on growth, yield and quality of guava through maximum use of land. BARI Peyara-2 was used in the study as variety. The experiment was laid out in a two factoral randomized complete block design with 3 replications. There were six levels of organic and inorganic fertilizer doses as T_1: control or farmer's practice, T_2: 100% Recommended dose/plant, T_3: 10 kg vermicompost + 10 kg cowdung + 50% Recommended dose/plant, T_4: 10 kg vermicompost + 10 kg cowdung + 25% Recommended dose/plant, T_5: 10 kg vermicompost + 75% Recommended dose/plant, T_6: 10 kg cowdung + 75% Recommended dose/plant and three types of sapacing as S_1: (1.5 x 3.0) m, S_2: (2.0 x 3.0) m and

S_3: (2.5 x 3.0) m. Results revealed that the highest fruit yield (15.22 kg plant-^{1}) due to highest individual fruit weight (278.67 g) and maximum number of fruits per plant (54.67) was recorded from the treatment T_5 (10 kg vermicompost + 75% Recommended dose/plant) and the lowest fruit yield (11.65 kg plant-^{1}) was noted in T_1 (control or farmer's practice). The highest fruit yield (14.10 kg plant-^{1}) was noted in S_2 (2.0 m x 3.0 m) compared to that of S_3 (2.5 m x 3.0 m) (12.75 kg plant^{-1}). The highest fruit yield (17.28 kg plant-^{1}) of guava was recorded with the combination of 2.0 m x 3.0 m spacing and 10 kg vermicompost + 75% Recommended dose/plant (S_2T_5) treatment, which was statistically at par to that of S_2T_3 (2.0 m x 3.0 m spacing and 10 kg vermicompost + 10 kg cowdung + 50% Recommended dose/plant) (16.40 kg plant-^{1}) and the least yield (9.91 kg plant-^{1}) was recorded from S_3T_1 (2.5 m x 3.0 m spacing and control or farmer's practice) treatment combination. Maximum vitamin C (mg/100g) content (366.00) was obtained in S_2T_5 (2.0 m x 3.0 m spacing and 10 kg vermicompost + 75% Recommended dose/plant) and minimum (206.00) vitamin C (mg/100g) content was noted in S_3T_1 (2.5 m x 3.0 m spacing and control or farmer's practice) treatment combination. Maximum TSS (10.00 %) was recorded from S_2T_5 (2.0 m x 3.0 m spacing and 10 kg vermicompost + 75% Recommended dose/plant) treatment combination compared to minimum (8.00%) TSS in S_3T_1 (2.5 m x 3.0 m spacing and control or farmer's practice).

Effect of split application of fertilizer on the harvesting time, yield and quality of ber

The study was carried out at the HRC Fruit Orchard, RARS, Jamalpur during the season of 2019-20. The treatments were: Factor-A: fertilizer dose: F_1= Recommended dose (1222 g Urea, 1000 g TSP,1000 g MOP, 281 g gypsum,15 g boron and 30 Kg cowdung), F_2= 150% of the recommended dose and F_3=200% of the recommended dose; Factor-B: split application of fertilizer: S_1= Total amount of fertilizer in one installment (at vegetative stage), S_2= Total amount of fertilizer in two installments (at vegetative stage + just after fruit set) and S_3= Total amount of fertilizer in three installments (at vegetative stage + just after fruit set +1 month after fruit set) and Variety: BARI Kul-1 and BARI Kul-2. A wide range of variations was observed in the treatments in terms of parameters studied. In consideration of effect of fertilizer dose and split application of fertilizer in terms of the plant characters, yield contributing characters and yield of BARI Kul-1, 150% of the recommended dose and total amount of fertilizer in two installments (at vegetative stage + just after fruit set) produced the highest yield (47.39 kg/plant). In consideration of effect of fertilizer dose and split application of fertilizer in terms of the plant characters, yield contributing characters and yield of BARI Kul-2, 200% of the recommended dose and total amount of fertilizer in two installments (at vegetative stage + just after fruit set) produced the highest yield (58.92 kg/plant).

Standardization of container culture method for mandarin cv. BARI Kamola-1

The experiment was conducted at Citrus Research Station, BARI, Jaintapur, Sylhet to standardize container size and growing media for mandarin cv. BARI Komla-1. The treatments comprised earthen containers of three sizes (20 L, 30 L, 40 Lof volume) and four growing media (a. Soil:FYM = 3:1; b. Soil:FYM = 2:1; c. Soil:FYM:Ash = 1:1:1 and d. Soil:FYM:Coco dust=1:1:1). A wide variation was observed in respect of growth, yield attributes and yield. Considering all the parameters it was evident that plants grown on 40 L container filled with Soil:FYM:Coco dust=1:1:1 performed the best irrespective ofstudied year with maximum number of fruits plant^{-1}and yield plant^{-1},with the highest concentration of total soluble solid (TSS%) and the lowest concentration of titratible acidity (TA). Therefore, the larger container (40L earthen pot) containing Soil:FYM:Coco dust=1:1:1 as growing media can be suggested for growing BARI Komla-1 at roof top condition.

Effect of rootstock and spacing on sweet orange

The field experiment was conducted at the fruit orchard of Regional Agriculture Research Station, Cumilla to observe the performance of different root stock and spacing on the growth and yield of sweet orange (BARI Malta-1). Five rootstocks like Rough lemon, Rangpur lime, Pummelo, Cleopetra and Calamansi were evaluated under the experiment. The plant height of BARI Malta-1 ranged from 1.55-2.58 m and plant volume ranged from 3.67-16.3m^3 with different root stock. Rangpur lime rootstock showed better performance concerning plant volume in 2018-19 than others.

Yield and profitability of sweet orange as influenced by organo-mineral fertilization in Cumilla region

Influence of organo-mineral fertilizers on yield and profitability of sweet orange was studied at the fruit orchard of Regional Agricultural Research Station, Cumilla. The experiment comprised eight treatment combinations viz., T_1: Native Fertility, T_2: RD of Chemical Fertilizers (120-30-50-4-1.5 NPKZnB/plant), T_3: RD of Chemical Fertilizers + 5 kg cowdung/plant, T_4: RD of Chemical Fertilizers + 10 kg cowdung/plant, T_5: RD of Chemical Fertilizers + 15 kg cowdung plant, T_6: RD of Chemical Fertilizers + 5 kg vermicompost/plant, T_7: RD of Chemical Fertilizers + 10 kg vermicompost/plant, T_8: RD of Chemical Fertilizers + 15 kg vermicompost/plant of organic and chemical fertilizers and replicated in three times. The plants were in vegetative growth stage. Plant height (2.47 m) and canopy structure N-S & E-W (1.10 m and 1.10 m) was the maximum with recommended dose of chemical fertilizers with 15 kg vermicompost plant^{-1} compared to other treatments. Fruiting data will be included after first fruit set in the experiment.

Response of sweet orange to dolochun in hilly area

A field experiment on sweet orange (Citrus sinensis L.) was conducted at the Regional Agricultural Research Station (RARS), Aakbarpur, Moulvibazar. The experiment started in July 2019 with the objectives to investigate the effect of dolochun on growth and fruit yield of sweet orange. There were four treatments comprising T_1: 0.5 Kg /Plant Dolomite T_2: 1.0 Kg /Plant Dolomite, T_3: 1.5 Kg/Plant Dolomite and T_4: Control. Data revealed that, T_2 ie. application of 1.0 kg dolomite per plant showed the highest no. of fruit 77/plant and the highest yield/ plant (12.19 kg) followed byTt_1 57.67fruit/plant (10.99 kg/plant). The lowest yield obtained from T_4 ie. control 38 fruit/plant (6.18 kg/plant).

Split application of fertilizer on growth, yield and quality of sweet orange

The study was carried out at the Fruit Orchard at RARS, Akbarpur, Moulvibazar. The treatments were: Factor-A: fertilizer dose: A_1= Recommended dose(113g Urea, 56g TSP,63g MOP,2.1 g $ZnSO_4$, 1 gm boron and 20Kg cowdung), A_2= 150% of the recommended dose and A_3=200% of the recommended dose; Factor-B: split application of fertilizer: B_1= Total amount of fertilizer in two installments (last week of May and October), B_2= Total amount of fertilizer in three installments (at last week of May, October and January) and B_3= Total amount of fertilizer in four installments (at last week of May, 1st week of September, 1st week of December and 1st week of March). A wide range of variations was observed in the treatments and treatments combinations in terms of parameters studied. Considering yield contributing characters and yield of sweet orange, 150% of the recommended dose produced the highest yield (9.58 kg/plant). On the other hand, considering yield contributing characters and yield of sweet orange, total amount of fertilizer in three installments (at last week of May, October and January) produced the highest yield (9.03kg/plant). In consideration of combined effect of fertilizer dose, split application of fertilizer in terms of the plant characters, yield contributing characters and yield of sweet orange 150% of the recommended dose, total amount of fertilizer in three installments (at last week of May, October and January) produced the highest yield (12. 05kg/plant). And 200% of the recommended dose, total amount of fertilizer in four installments produced the lowest yield (5.68 kg/plant).

Effect of different doses of glufosinate-ammonium 88% (expert 88 wdg) for controlling weed in citrus field

A field trial was conducted at the Fruit Research Farm of BARI, Joydebpur, Gazipur to find out the optimum dose of herbicide to control weed in the citrus field. Five treatments i.e. T1: spraying of expert 88 WDG @ 2.5 g/litre of water, T2: spraying of expert 88 WDG @ 3.0 g/litre of water, T3: spraying of expert 88 WDG @ 3.5 g/litre of water, T4:Two hand weeding at 25& 50 DAE (Days After Establishment) and T5: no spray

(Control) were included in this study. Number of weed/m^2 and weed control efficiency (WCE) was influenced by different treatments. Maximum (123 and 200) weeds/m^2 was recorded in control plot at 25 & 50 DAE, respectively and minimum 27 weeds/m^2 were recorded in T_4 followed by T_3 treatment (31 weeds/m^2) respectively. The highest weed control efficiency 81.43% and 88.10% was found in T_3 treatment at 25 DAE followed by T_4 treatment (80.95% and 86.47%) in field-1 and field-2. The results revealed that spraying of herbicide (Expert 88 WDG @ 3.5 g/litre of water) was most effective in controlling weeds upto 25-35 days of herbicide spraying. The herbicide action was shown quickly after spraying one day.

Influence of nut weight and method of planting on germination and seedling growth of coconut

The present study was conducted at Regional Horticultural Research Station, RARS, Rahmatpur, Barishal to evaluate comparative growth of coconut seedlings in relation to its weight and method of planting of seed nut. The experiment was laid out in a Randomized Completely Block Design with two factors. Factor A: consists of four nut weight i.e. W1: <1000 g, W2: 1001-1200 g, W3: 1201-1400 g, W4: >1400 g and Factor B: consists of two method of planting, i.e. P1: Horizontal, P2: Vertical was replicated three times with 16 nuts in each treatment. The percentage of germination in both methods recorded an increasing trend with the increase in weight of seed nut. Irrespective of the weight of nuts the early and higher percentage of germination was recorded in vertical method of planting as compared to horizontal method. In vertical method of planting highest germination percentage of 38.02, 56.77, 70.83 and 83.85 was recorded as compared to 26.04, 44.25, 56.25 and 65.10 in horizontal method of planting during second, third, fourth and fifth month after planting respectively indicating differences between the two methods of planting. In respect of weight of nut the minimum nut weight (<1000g)) recorded lowest germination percentage of 25.00, 46.88, 59.38 and 70.83 during second, third, fourth and fifth month after planting against highest germination percentage of 36.46, 56.25 and 67.71 during second, third and fourth month after planting under heaviest nut weight (>1400g) with nut weight (1201-1400g) get maximum germination during fifth month after planting. In case of plant height, in every stage of observation, the higher values were observed in vertical planting as compared to horizontal planting. At 9 month after planting maximum seedling height (86.08cm) was noticed in vertical planting as compared to horizontal planting (79.42cm). In case of collar girth, maximum collar girth (3.29cm) was noticed with vertical planting as compared to horizontal planting (3.18cm). The collar girth showed an increasing trend with increasing weight of seed nuts irrespective of method of planting (Table 4). In respect of weight of nut the minimum nut weight (1201-1400g) recorded lowest collar girth of 3.13cm during fifth month after planting against highest collar girth of 3.37cm in fifth month after planting under heaviest nut weight (>1400g). The significant variation in respect of number of leaves with different method of planting and weight of seed nuts. During the four months of observation i.e. from 6th to 9th months after planting the leaf number increased from 3.54 to 6.12 under vertical planting as compared to 3.22 to 5.95 under horizontal vertical method of planting. Irrespective of month of planting, with the increase of seed weight, the variation in leaf number were 3.23 to 5.96, 3.40 to 5.99, 3.42 to 6.04 and 3.47 to 6.14 respectively during the 6th , 7th , 8th and 9th month after planting. From the experimental findings, it may be concluded that the vertical method of planting with higher nut weight gave higher germination and better seedling as compared to horizontal method of planting.

Development of a fertilizer management package for dragon fruit cultivation in Bangladesh

A study was carried out at Horticulture Research Center, Regional Agricultural Research Station, Jashore to develop fertilizer management package for dragon fruit cultivation in Bangladesh. Five packages with different combinations *viz*; P_1 (Urea = 217 g, TSP 500 g MoP 200 g and 2 kg Manure@ once a month), P_2 (Urea 110g, TSP 250g , MₒP 100g and 2 kg manure @ every 4 months), P_3 (Urea 435g, TSP 1 kg and MoP 400 g/2 months), P_4 (Urea 435 g, TSP = 1 kg, MoP 400 g/2 months and 5 kg manure @ every 4 months) and P_5 (Urea 72 g, TSP 88 g, MoP 40 g /4 months and 20 kg manure/year) were included in the experiment. All the parameters under study were varied significantly among the treatments except TSS %. However, the treatment P_3 produced the tallest plant (2.87 m) and the shortest plant was found in the treatment P_2 (2.66 m). No. of fruits/plant was observed maximum (17.69) in the treatment P_3 followed by the treatment P_1 (16.57) and minimum from P_2 (11.27). The longest fruit (9.44 cm) was obtained from the treatment P_4 closely followed by the treatment P_3 (8.42 cm) and the smallest fruit was produced by the treatment P_2 (7.60 cm). The highest fruit diameter was found in P_5 (7.58 cm) and the lowest in P_2 (6.17 cm). Individual fruit weight was observed the highest in the treatment P_4 (144.78 g) followed by P_3 (237.19 g) and the lowest was found in the treatment P_5 (204.54 g). The highest fruit yield (13.21 t/ha) was also obtained from the treatment P_3 which was closely followed by the treatment P_1 (12.31 t/ha). On the other hand, the lowest fruit yield was recorded in the treatment P_5 (3.71 t/ha).

Effect of day length enhancement through night breaking by artificial lighting on off season fruit production of dragon fruit in Bangladesh

A factorial experiment with eighteen treatment combinations was conducted at dragon fruit orchard of Agricultural Research Station, Pahartali, Khulshi, Chattogram to find out the best light duration and light intensity for off season dragon fruit production. Two factors were light intensity and light duration. The performances of 6 hours light intensity was significantly superior than other treatments in the case of number of bud/pillar (43.80), number of fruit/pillar (43.80), fruit length (9.31 cm), fruit breadth (8.5 cm), individual fruit weight (344.6 g), fruit yield (16.58 t/ha). The treatment 100 W IB showed superior performance over other treatments in the case of bud/ pillar (49.4), fruit/pillar (34.5), fruit length (9.54), fruit weight (336.9 g), TSS (9.28 %), yield (18.13 t/ha). Treatment combination (100 W IB light for 6 hrs) produced the highest number of fruit/ pillar (36.3), bud/pillar (54.0), fruit length (9.66 cm), fruit breadth (8.99 cm), fruit yield/ pillar (12.41 kg) and fruit yield/ha (19.85 t).

Effect of cutting length and time of cutting on the success and survivability of dragon fruit propagation

In order to find out the suitable cutting length and time of cutting for the successful propagation of dragon fruit (BARI Dragon Fall-1) was carried out in the research field of Regional Agricultural Research Station, BARI, Jamalpur following CRD design with 3 replications. The experiment consisted of six different stem cutting 1ength size, 10, 20, 30, 40, 50 and 60 cm and twelve months of cutting operation started from January, 2019 to December, 2019. In case of days to bud break, the shortest period (40.17 days) was required by the cutting length of 60cm, while the longest period (55.67days) was recorded in the cutting length of 10cm. The highest 94.92% successful cuttings were noticed in the cutting length of 50 cm , on the contrary the lowest 92.83 % successful cuttings were found in the smallest cutting length of 10 cm after 3 months of cutting operation. The longest new shoots (67.27 cm) was recorded in the cuttings of 60 cm length after 90 days of cutting operations as against minimum (12.67cm) in the cuttings of 10 cm length. In case of days to bud break, the shortest period (< 30 days) was required by the month of February to June While the longest period (>60days) was recorded in the months of September, October and November. The highest success and survivability of cuttings (>95%) were noticed in the months of February to April, on the contrary the lowest (up to 95 %)% successful cuttings were found in the month of July to December. The highest number of new shoots (4.30 to 5.67) were noticed in the month of March and April, on the contrary the lowest <1 were found in the months of August and September after 3 months of cutting operation. This might be due to the favorable climatic condition during this period such as moderate temperature and relative humidity.

Effect of split application of fertilizer on growth and yield of golden apple

Influence of fertilizer dose and its application method on the growth and yield quality of BARI Amra-1 was studied at the Fruit Research Farm of HRC, BARI, Joydebpur, Gazipur. Three different levels of fertilizer i.e., F_1: 100% of the dose (N: 100

g, P: 50 g, K: 90 g, S: 15 g, B: 1.5 g and Cowdung: 15 kg); F_2: 150% of the dose and F_3: 200% of the dose per plant mentioned in the FRG, 2018 in combination with four application methods were used as treatments of the experiment. All the fertilizers except urea and MoP were applied during final land preparation as basal dose and the rest of urea and MoP are being applied in splits as per treatments. Urea and MoP were splitted I_1: twice (September and April), I_2: thrice (September, March-April and May-June) and I_3: four times (September, November, March-April and May-June) and the other application method was I_0: the application of whole urea and MoP at a time (September-October). Harvesting is not completed yet. Among the collected data superiority in number of fruits retained per panicle (3.44) was recorded from plants treated with 150% of the dose per plant mentioned in the FRG, 2018. Control plants always exhibited minimum number of fruits per panicle. The highest number of panicles/plant (10.00) and fruits retained per panicle (11.53) were counted in plants received 200% of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied twice and the lowest number of panicles/plant (4.00) and fruits retained per panicle was recorded (4.04) in plants where 100% of the dose/plant mentioned in the FRG, 2018 was applied at a time.

Growth, yield and quality as influenced by split application of fertilizer on BARI Amra-2

Influence of fertilizer dose and its application method on the growth and yield quality of BARI Amra-2 was studied at the Fruit Research Farm of HRC, BARI, Joydebpur, Gazipur. Three different levels of fertilizer i.e., F_1: 100 % of the dose (N: 100 g, P: 50 g, K: 90 g, S: 15 g, B: 1.5 g and Cowdung: 15 kg); F_2: 150 % of the dose and F_3: 200 % of the dose per plant mentioned in the FRG, 2018 in combination with four application methods were used as treatments of the experiment. All the fertilizers except urea and MoP were applied during final land preparation as basal dose and the rest of urea and MoP are being applied in splits as per treatments. Urea and MoP were splitted I_1: twice (September and April), I_2: thrice (September, March-April and May-June) and I_3: four times (September, November, March-April and May-June) and the other application method was I_0: the application of whole urea and MoP at a time (September-October). Harvesting as well as data collection on yield and post-harvest attributes are not completed yet. Superiority in number of fruit retention was recorded from plants treated with 200% of the dose per plant mentioned in the FRG, 2018. Control plants always exhibited minimum number of fruits per panicle. The highest number of panicles per plant (39.69) and fruits retained per panicle (5.45) were counted in plants received 200% of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied thrice (F_3I_2) and 200% of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied twice, respectively.

Combined effect of organic and inorganic fertilizer on growth, yield and quality of strawberry

Strawberry (*Fragaria X annanassa* Duch.) is responsive to organic and inorganic fertilizers. Hence, an experiment on strawberry was conducted in fruit research field of Horticulture Research Centre, BARI, Gazipur during 2019-20 to evaluate the combined effect of organic and inorganic fertilizers on yield and quality of strawberry. Eight treatments were tested in this trial. The treatments were T_1= Control, T_2= 100% RDF (FRG, 2018), T_3= 125% RDF+5 t vermicompost ha^{-1}, T_4= 125% RDF+3 t poultry manure ha^{-1}, T_5=125% RDF+5 t cowdung ha^{-1}, T_6= 75% RDF+5 t vermicompost ha^{-1}, T_7= 75% RDF+3 t poultry manure ha^{-1}, T_8= 75% RDF+5 t cowdung ha^{-1} including blanket dose 8 kg Mg ha^{-1}. The experiment was set up in a randomized complete block design with three replications. Results showed that treatment T_4produced highest strawberry fruit yield (4.81 t ha^{-1}) followed by T_5treatment. The lowest fruit yield (3.40 t ha^{-1}) was found in control treatment. Most of the cases, yield attributes were more pronounced in the same (T_4) treatment. The highest TSS (^{0}Brix 7.6) and vitamin C (70.5 mg 100 g^{-1}) was estimated in T_4 treatment. So, the result suggest that application of 125% RDF with 3 t $ha^{-1}$of poultry manure along with blanket fertilizer of Mg 8 kg ha^{-1} can support to get higher yield and improved the quality of strawberry.

Standerdization 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 HRC, BARI, Gazipur. 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 % Burneded Rice Husk + 25% Vermicompost, T_8:50% Soil + 25 % Burneded 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% Burneded Rice Husk, T_{18}:100% Soil. Maximum plant height was observed in the medium comprising 50% Soil +50% Cowdung (T_1) (3.60 m) and minimum plant height was noted in the medium of 50% Soil +50% Mustard Oil Cake (T_{13}) (1.91 m). Maximum tree volume was recorded in T_1 (7.92 m^3). Number of fruit set per panicle (26.00) was attained maximum in T_2 (50% Soil + 25 % Sand + 25% Cowdung) and minimum (07.00) was noted in T_{13} (50% Soil +50% Mustard Oil Cake). The biggest fruit in terms of weight was recorded in T_2 (50% Soil + 25 % Sand + 25% Cowdung) (211.67 g) followed by $T_{16,}$ T_{18} and T_3 (188.50 g, 182.00 g and 170.00 g, respectively). The smallest fruit was obtained from T_{14} (50% Soil + 25% Mustard Oil Cake+25% Sand) (144.33 g). TSS (%) ranged from 27.13 % to 20.50 %, where T_2 had maximum (27.13 %) TSS (%) and the minimum (20.50 %) TSS content was noted in T_1 (50% Soil +50% Cowdung). Yield per plant (6.60 kg) was recorded the highest in T_2, followed by T_3 (5.78kg) and T_4 (6.04 kg), where the lowest yield was obtained from T_{13} (50% Soil +50% Mustard Oil Cake) (2.27 kg/plant), followed by T_9 (50% Soil + 25 % Sand +25% Tricocompost) (3.06 kg/plant). There was no insect infestation among the treatments. Only in $T_{13,}$ T_{14}, T_{17} and T_{18} a little bit of jelly seed incidence was observed, which ranged from 0.29% to 6.1%. Incidence of jelly seed (%) was recorded the highest in T_{18} (6.1%) and the lowest in T_{17} (0.29%). Among the treatments $T_{6,}$ T_{13} and T_{15} were affected by anthracnose disease, where T_{15} had the highest infection caused by anthracnose i.e. 5.2 %). Rests of the treatments were found totally free from any type of infestation, infection and physiological disorders.

Standerdization of soil media for roof gardening of guava

An experiment was conducted at the RARS, Jamalpur to standardize the soil media in terms of plant growth, fruit retention as well as yield and quality of guava for roof top gardening. There were seven treatments i. e. T_1 = 50 % soil + 50 % cowdung, T_2 = 75 % soil + 25 % cowdung, T_3 = 50 % soil + 25 % sand+ 25 % cowdung, T_4 = 50 % soil + 50 % vermicompost, T_5 = 75 % soil + 25 % vermicompost, T_6 = 50 % soil + 25 % sand + 25 % vermicompost, T_7 = 100% soil. The highest plant height (2.3 m) was observer in 50 % soil + 50 % vermicompost followed by 50 % soil + 50 % cowdung (2.2 m), 75 % soil + 25 % vermicompost (2.1 m), 50 % soil + 25 % sand + 25 % vermicompost (2.1 m) and the lowest plant height (1.95 m) was observed in 100% soil (control). The highest tree volume (4.20 m^3) was found in 50 % soil + 50 % vermicompost followed by 50 % soil + 50 % cowdung (3.87 m^3), 50 % soil + 25 % sand + 25 % vermicompost (3.16 m^3), 50 % soil + 25 % sand+ 25 % cowdung (2.61 m^3) and the lowest tree volume (1.54 m^3) was obtained from 100% soil (control). The maximum number of fruits plant-1 (29.3) was observed in T_4 treatment whereas the minimum number of fruits plant^{-1} (13.0) was observed in 100% soil (control).

Standardization of container size and growing media for successful cultivation of sweet orange cv. BARI Malta-1 under roof top conditions

The experiment was conducted at Citrus Research Station, BARI, Jaintapur, Sylhet to standardize container size and growing media for sweet orange cv. BARI Malta-1. The treatments comprises of three container size (20 L, 30 L, 40 L diameter) and four container ting media (a.

Soil : FYM = 3:1; b. Soil : FYM = 2:1; c. Soil : FYM : Ash = 1:1:1 and d. Soil:FYM:Coco dust = 1:1:1). Irrespective of studied year40 L container filled with Soil:FYM:Coco dust=1:1:1)performed better in terms of plant height, base girth, individual fruit weight, number of fruits plant^{-1}and yield plant^{-1} as well as quality attributes of fruit (Total soluble solids and titratible acidity). Therefore, this larger container (40 L earthen pot) containing Soil:FYM:Cocodust=1:1:1 as growing media might be suggested for the city dwellers for growing sweet orange under roof top condition.

Standardization of soil media for roof top gardening of dragon fruit

An experiment was conducted at the RARS, Jamalpur to standardize the soil media interms of plant growth, fruit retention as well as yield and quality of dragon fruit for roof top gardening. There were seven treatments i. e. T_1 = 50 % soil + 50 % cowdung, T_2 = 75 % soil + 25 % cowdung, T_3 = 50 % soil + 25 % sand+ 25 % cowdung T_4 = 50 % soil + 50 % vermicompost, T_5 = 75 % soil + 25 % vermicompost, T_6 = 50 % soil + 25 % sand + 25 % vermicompost, T_7 = 100% soil.The highest plant height (2.38 m) was observer in 50 % soil + 50 % vermicompost followed by 50 % soil + 50 % cowdung (2.36 m), 75 % soil + 25 % vermicompost (2.19 m), 75 % soil + 25 % cowdung (2.17 m) and the lowest plant height (1.75 m) was observed in 100% soil (control). The highest tree volume (4.28 m^3) was found in 50 % soil + 50 % vermicompostand the lowest tree volume (1.91 m^3) was obtained from 100% soil (control). The maximum number of fruits plant^{-1} (8.66) was observed in 50 % soil + 50 % vermicompost and 50 % soil + 50 % cowdung whereas the minimum number of fruits plant-1 (2.0) was observed in 100% soil (control).

Maintenance of different fruit germplasm at HRC, RARS, Jamalpur

HRC, RARS, Jamalpur is maintaining 2571 germplasm of 47 crops both indigenous and exotic germplasm in the field genebank. The fruit germplasms are mango, litchi, banana, guava, jackfruit, jujube, aonla, bael, bilimbi, bullock’s heart etc. The vegetable germplsms are elephant foot, drumstick etc. The exotic germplasms are avocado, pear, tamarind, coffee, passion fruit, dragon fruit and tisa etc. The intercultural practices were done as and when necessary.

Survey and collection of pathogen isolates of panama disease of banana

In Bangladesh, the most common and widely damaging disease of banana is panama caused by Fusarium oxysporum f. sp. cubense (FOC). The survey area was covered during 2017-18, 2018-19 and 2019-2020 at Bogura, Rangpur, Faridpur, Jashore and Cumilla only with the objectives to collect the isolates, purify and preservation of the panama causing fungus for characterization in banana production. Panama disease was found in the every area surveyed. Incidence of panama disease ranged from (5-90%). The highest disease incidence (90%) was found in Chapa at Chupinagar, Shahjahanpur, Bogura (24077'04"N,89050'45"E) and the lowest disease incidence (5%)was recorded in Sabri/Anupom and Plantain varieties at Gabtoli, Bogura (24051' 54.061"N, 89024' 57.306"E).

Incidence and severity to botrytis blight disease of lilium

Survey was conducted in Floriculture research field of Horticulture Research Centre, BARI, Gazipur during December 2019 to March 2020 to record the incidence and severity of botrytis gray mold disease of lilium.The surveyed germplasm were 001, 005, 006, 007, 008, 010, 011,013, 014, 015, 017, 022, 024, 025, 026, 027, 028, 061,067 and 077. The disease incidence and severity of botrytis blight of lilium were assed on the basis of the symptoms such as yellowing and drying of leaves of plants. Disease incidence of botrytis blight of lilium was 70-100% in 022, 024, 025, 005, 006, 007, 008, 010, 011, 014, and 027. Disease incidence was 55% in 026. Disease incidence was 10-12% in 001, 017, 028, 061, 067 and 077 and 0% in 015 and 013. The highest PDI (100%) found in 011 and lowest (0%) in 013 and 015. The PDI (10-50%) found in 001, 005, 006, 026, 007, 008, 010, 011, 014, 017, 022, 025, 026, 027, 028, 061, 067 and 077.

Dissemination of mango bagging with double layer brown paper bag technology for controlling fruit fly, *Bactrocera dorsalis* in high rainfall and hilly areas of Bangladesh

The experiment was conducted in research fields of Hill Agricuture Research Station (HARS), BARI, Raikhali, Rangamati Hill district during February to July 2020 to disseminate and popularize the fruit bagging technology for controlling mango fruit fly in high rainfall and hilly areas. Randomized Complete Block design was followed with four treatments and four replications. The treatments were, Treatment$_1$= Bagging by double layer brown paper bagat six weeks before mango harvest, Treatment$_2$= Installation of sex pheromone trap, Treatment$_3$= Farmers' practice (Foliar spray of Shobicron 425EC @ 1.5ml/L of water)and Treatment$_4$= Control. Results revealed that bagging of mango with double layer brown paper bags showed the best performance in reducing fruit fly infestation (100%) and increasing of marketable yield over control (165.43%) and maximum marginal benefit cost ratio (2.08).

Post harvest

Comparison of blanching method between boiling water and microwave on the quality of frozen green jackfruit

Microwave and boiling water blanching method were compared in this study to determine their effects on some quality characteristics of unripe jackfruit just after blanching and during frozen storage. After blanching jackfruit pieces (1 cm thick) were cooled, packed in high density polyethylene bag and stored at -20°C. The effectiveness of each blanching process was performed measuring the loss of peroxidase activity that results more rapidly in microwaves (2.5 min) than in boiling water (3 min). After blanching, firmness of unripe jackfruit pieces was reduced slightly but during frozen storage blanched unripe jackfruit preserved their firmness efficiently than the unblanched one. The highest firmness value (0.92N) was found in microwave blanching (MWB) green jackfruit and this value was 0.85n in boiling water blanching (BWB) and only 0.24n in unblanched green jackfruit at 8 months of frozen storage. Besides, minimum colour was changed in blanched unripe jackfruit compared to unblanched one. During frozen storage, unblanched jackfruit lost its sensory quality in all aspects significantly and after 8 months of storage it was become unacceptable (scored less than 4) whereas blanched jackfruit pieces (both MWB& BWB) was good (scored around 7) even after that time.

Enhancing the ripening process of banana 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 banana. Bananas were harvested and exposed to ethylene gas that generated from ethephon (48 sl) by low-cost simple 'ethynene generator'. Three concentrations of ethephon i.e. 50,100 and 150 ppm were used as source of ethylene gas. Bananas were exposed to ethylene gas for 24h at ambient storage (27±1°c and 70±5% rh) condition for uniform ripening. Ethylene gas generated from 50, 100 or 150 ppm ethephon exhibited the highest efficacy in fruit ripening for 24h. Treatment with ethylene gas resulted in 99% fruit ripe with uniform yellow colour, desirable firmness and acceptable quality after end of three 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 banana. In this process ethephon at very low concentration (50 ppm) found enough to triggering the ripening process of banana fruit for marketing. Thus, postharvest application of ethylene gas generated from ethephon using low-cost ethylene generator may be used for commercial banana ripening. This is the first year's trial. Therefore, more research is needed with lower concentration of ethephon to generate additional information and further confirmation of the results.

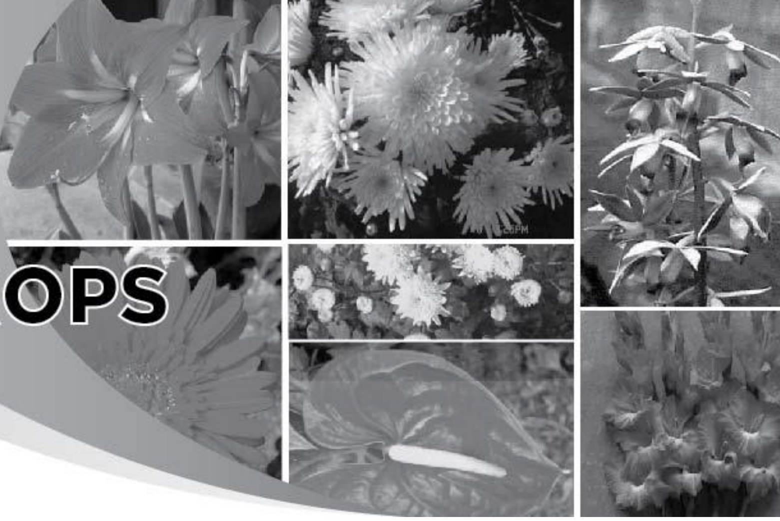
Novel coconut oil and beeswax edible coating for postharvest green life and quality preservation of lemon at low temperature

An experiment was conducted to assess the influence of coconut oil and beeswax edible coating and modified atmospheric packaging (MAP) on postharvest storage quality of lemon at 12±1°C. Sorted lemons were washed with drinking water fruit surface water was removed and then coated with coconut oil-beeswax (90:10) or only coconut oil. After coating, lemons were kept in map or crates and stored at 12±1°C and 85±5% RH. Weight loss, respiration rate, firmness, external colour (hue angle and lightness), shrinkage, yellowing, TSS, pH, acidity, ascorbic acid, and also organoleptic quality (colour, flavour, texture and overall acceptability) were analysed periodically during storage. The results revealed that coconut oil-beeswax coating had immense effect on retaining green colour, reducing respiration, weight loss, shrivelling and preserving firmness of lemon throughout the storage. On the other hand, map mainly helps to retain moisture & firmness and reduce shrivelling. Based on all sensory, physical and chemical parameters uncoated open lemon was acceptable up to 1 week, coconut oil coated kept open was 3 weeks, coconut oil coated kept map was 7 weeks, coconut oil-beeswax coated kept open was 6 weeks and coconut oil-beeswax coated kept map was 8 weeks with good quality and green skin colour.

Effect of heat treatment and packaging in storage of fresh cut golden apple

Fresh cut (FC) golden apple (*Spondias dulcis Forst*.) slices were treated in warm (60°C) water and some slices were not treated. Surface water was removed from the slices and then was kept into one of three packaging techniques such as i. Styrofoam try without wrapping ii. Styrofoam try with cling wrapping iii. Vacuum LDPE bag respectively and stored into refrigerator (5±1°C and 50±5% RH). The effectiveness of the treatments in extending shelf-life was evaluated by determining respiration rate, firmness, weight loss, external colour, some chemical parameters (ascorbic acid content, TSS, acidity, FC, total sugar and reducing sugar), total bacterial count (TBC) and sensory quality. Vacuum packed fc golden apple (heat treated or non-treated) obtained more than 6 scores whereas cling film wrapped one scored less than 4.5 in case of all sensory quality attributes at 20th day of storage while, open fresh cut golden apple (treated and non-treated) secured scores less than 4 at 10th day of storage. The highest amount (8.6 logCFU/g) of total bacterial count (TBC) was observed in without treated and wrapped with cling film FC golden apple while it was only 5.81 log CFU/g in fresh cut golden apple treated with warm water and packed in vacuum LDPE bag at 20th day of storage. Based on all sensory, physical and chemical parameters unpacked without wash fresh cut golden apple was acceptable up to 3days, FC golden apple kept in styrofoam tray and wrapped with cling film was acceptable up to 16 days and vacuum packed FC golden apple was acceptable for more than 20 days.

07 FLOWER CROPS



Collection, evaluation, characterization and maintenance of lilium

The present experiment has been under taken to collect and characterize the different species of lilium available in Bangladesh and also from abroad and to conserve the collected germplasm for future research. Thirty genotypes of lilium were evaluated under lilium shed at Floriculture Division, Horticulture Research Centre, BARI during 2019-20. Significant variations on different qualitative and quantitative parameters were observed among the genotypes under study. Among them 24 germplasm are suitable for cut flower and 6 are suitable for pot culture. Lilium genotypes showed wide variation in all qualitative and quantitative parameters studied. Among the collected lilium germplasm, 30 attractive coloured and two types of flowers *viz*., Asiatic lilium and Oriental lilium was found. Among them 24 germplasm are suitable for cut flower and 6 were suitable for pot culture. Regarding fragrance, Oriental type lilium produced strong scented flowers whereas Asiatic types had no fragrance. The longest stalk (85.80cm) and the rachis (31.98cm) were produced by the genotype Lil-018 and Lil-026, respectively. The maximum number of florets per stick (10.50) were produced by the genotype Lil-001. The maximum vase life was observed in Lil-007 and Lil-010 (12.0 days) whereas the minimum in Lil-022 and Lil-026 (5.0 days). The heaviest bulb (60g) was produced by the genotypes Lil-007 and Lil-012 and the largest bulb (6.06cm) were produced by the genotype Lil-007.

Collection and maintenance of cactus

Twenty-six cactus genotypes were collected and maintained at Floriculture Field of HRC, BARI, Gazipur. Wide variation in respect of vegetative and floral traits was observed. Among the genotypes, Cac-011 exhibited distinctly large flower than the others. Flower durability varied from 2.0 to 7.0 days. The genotypes Cac-015 and Cac-016 produced higher number (15.0 and 13.0, respectively) of flower whereas Cac-008 produced lowest number of flower (2.0). A large variation was found in shape, size and colour of the observed genotypes.

Collection and maintenance of succulents

Succulents are the xerophytic plants and members of the family Agavaceae, Euphorbiaceae Crassulaceae and Liliaceae etc. with swollen fleshy parts, curious forms, diversity of shape and colour. They can store water to survive in the drought condition. Succulent 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. Their soft nature and easy cultivation in shallow soils are additional features for their popularity. Twenty lines of succulents were collected and maintained at Floriculture Division, Horticulture Research Centre, BARI during 2019-20 for decorative and commercial purposes.

Collection and maintenance of rose genotypes

The genotypes of rose were collected and characterized at Floriculture division of HRC, BARI during 2019-20. The performance of ten genotypes of rose exhibited variation on different parameters. In respect of flower colour, the observed genotypes showed remarkable variation such as yellow, orange, yelloish orange, pink, light pink, yellowish white, red, maroon etc. The tallest plant of 98.0 cm recorded in the genotype R-003 and shortest of 62.0 cm in R-009. The production of maximum number of branches per plant (5.0) was recorded in genotype R-005 followed by 4.5 shoot in genotype R-004. The genotype R-002 produced the highest stalk length of 9.7 cm (Table 1). Maximum flower number was recorded in R-005 (15.0). In respect of flower size, genotype R-004 (9.2 cm) found superior to others. The genotype R-005 exhibited the maximum flowering duration (7.0 days) while minimum duration of 5.0 days was recorded in R-010.

Collection and evaluation of aster genotypes

The investigation was carried out on aster genotypes to find out the best line(s) for cut flower in Banglaldesh. Based on flower colour, flower number, flower size and flower durability, A-001 and A-004 were identified as good genotypes.

Collection, evaluation and maintenance of heliconia

Heliconia is a dwarf plantain like plant belongs to Musaceae family native to South Africa. It is grown both for cut flowers and for garden or bed decoration purposes. It deserves special importance due to easy culture, wide adaptability to soil and climate, summer production and less prone to disease and pests. Recently, the demand of this flowering plant is increasing due to its attractive colour, prolonged shelf life and economic value. Based on flower colour, erect habit, shoot number and vase life, H-004, H-005, H-007 and H-008 were identified as good genotypes.

Collection and evaluation of tuberose (*Polianthes tuberosa* L.) genotypes

Tuberose (*Polianthes tuberosea* L.) is one of the most important flowering plants which is native to Mexico and belongs to family Agavaceae (formerly known as Amaryllidaceae). It can be cultivated both in tropical and sub-tropical condition. It produces conspicuous and showy cut flower that are important as commercially and aesthetically. It is getting more importance among growers and floriculturists due to its production in summer and autumn season due to the unavailability of other ornamental flowering bulbs during this period. It is considered as one of the most important fragrant truncated (cut branch) flowers of tropical and semitropical areas which are in worthy consideration in the perfume Industry. It is also used in floral arrangements, for making bouquets, garlands etc. Six tuberose genotypes with BARI Tuberose-1 as check variety were evaluated at the Floriculture Research Field of HRC, BARI, Gazipur during 2019- 2020 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 (17.07) to reach 50% germination of bulbs and also to reach 50% spike initiation (88.75days). TR-001 produced the longest spike (88.0cm). The longest rachis (43.45cm) was recorded by TR-004. The maximum number of flower sticks/ha (2,64,000 sticks) were recorded in TR-003. The heaviest (32.20g) and the largest bulbs (3.48cm) were recorded by TR-001. BARI Tuberose-1 remained fresh for the longest time (14.75days) in the field and also in the vase (7.0 days). The highest percentage of florets (68.80%) was opened in the vase by the genotype TR-004. Tuberose genotypes showed wide variations in all qualitative and quantitative characters. The genotype TR-001, TR-004 and TR-005 produced heavy scented flowers. The longest spike, the heaviest and largest bulb were produced by TR-001 and TR-004 produced the longest rachis. The longest floret and the maximum flower yield/ha were recorded in TR-003. The highest percentage of florets was opened by the genotype TR-004.

Collection and maintenance of carnation genotypes

The present study was undertaken to evaluate of carnation genotypes for flowering. An experiment was conducted at Floriculture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during February 2019 to June 2020. Experiment consisted of four carnation genotypes viz. white (V_1), red (V_2), pink (V_3) and light pink (V_4). Maximum plant height (60.5 cm), leave number (21.5), internode number (7.8), first appearance of flower bud (70.0 days), flower stalk length (50.0 cm), number of petal (30.0), number of flower (7.0) was found from V_2 (red) genotype. Significant variation was also found in vase life and flowering duration. Among the genotypes, V_2 exhibited the longest vase life and flowering duration of 10.0 and 18.3 days followed by V_3 (9.8 and 17.9 days). Carnation genotypes showed a significant variation for different growth and flower characters and genotypes V_2 (red) showed best performance.

Collection and maintenance of tulip

The tulip (*Tulipa gesneriana*) is a perennial, bulbous plant belongs to family Liliaceae. Tulips are excellent for cut flowers, growing in beds, borders and pots and also for indoor gardening. Tulip flowers come in a wide variety of colours therefore it is widely used as garden flowers and also in flowering arrangements. They are suitable for naturalization in grass under the trees and shrubs. It is the top most flowering genotype of the Netherlands and occupies fourth position among the top ten cut flowers in the global floriculture trade. In India, tulips thrive well in the temperate regions and other similar hilly regions but do not grow satisfactorily in the plains. However, there is scope of growing tulips for the production of quality cut flowers and bulbs in the tropical regions also. Six germplasm were collected from Netherlands used for the study. Variations were observed in respect of flower colour, leaf colour, leaf size and flower durability.

Performance on growth and flowering behaviour of dendrobium genotypes

The present investigation was carried out to study the performance of twelve genotypes of Dendrobium orchid coded from V_1 to V_{12} (Dendrobium Alba, Dendrobium Red, Dendrobium Candy Stripe, Dendrobium Sharifa Fatema, Dendrobium Sonia, Dendrobium Thong Chai Gold, Dendrobium Malay, Dendrobium Jenny Denny, Dendrobium Bicolour, Dendrobium Yellow, Dendoribum Paradise and Dendrobium Asian Beauty respectively) under shade net house conditions with an aim to find out suitable variety in Gazipur. Vegetative and flowering characters varied significantly among the genotypes. Longest plant (40.0 cm) and maximum grith of pseudobulb (15.2 mm) was found with Dendrobium Sonia genotypes. For the same genotypes, maximum other growth and flowering characteristics were observed and recorded as number of pseudobulb/plant (5.0), number of leaves/pseudobulb (12.0), leaf area (35.9 cm^2), number of spikes/plant (3.5), spike length (35.0 cm), number of florets/spike (14.5), rachis length (15.5 cm), fresh weight of spike (30.0 cm) and longest vase life (24 days). On the basis of result obtained and summarized from present study, it can be concluded that variation in genotypes with respect to growth and yield characters mainly attributed due to genetic and environmental interaction. Average performance of 'Dendrobium Sonia' is excellent followed by 'Dendrobium Alba' and 'Dendrobium Thong Chai Gold' having all the growth and flowering potentiality as evaluated suitable for growing in Gazipur condition.

Performance of BARI developed gladiolus varieties at Jamalpur Region

The study was undertaken to evaluate the performance of different varieties of gladiolus in order to select promising genotypes under Jamalpur condition. It revealed from the study that BARI Gladiolus-4, BARI Gladiolus-5 and BARI Gladiolus-3 found more suitable 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

Performance of exotic ornamental gourds lines

Eighteen ornamental cucurbit lines were collected and evaluated at the research field of Floriculture Division, Horticulture Research Centre, BARI and RARS, Burirhat, Rangpur during the Rabi season of 2019-20120 to observe the adaptability as well as yield and storage duration. Wide variability was observed among the lines. The number of fruit per plant was range from 3.5-6.8; fruit weight range from 105.0 - 320.0 g. The range of fruit size was 4.2-12.4 cm. Fruit yield varied from 0.5-2.2 kg per plant. Storage duration was good ranging from 158.0-310.0 days. Considering attractive fruit colour, shape, size and storage duration, all the line may be selected for detail study. Considering attractive fruit shape, skin colour and storage condition, all the lines may be used for decorative purposes.

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, a hybridization program on gladiolus was conducted in the flowering season November 2017 to May 2020 at Floriculture Farm, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur. Four crossing were done among five attractive gladiolus genotypes and pods were successfully produced. A large number of cormels were produced from a single cross.

Success of cactus grafting as influenced by rootstock and scion

The experiment was conducted at Floriculture division of Horticulture Research Centre, BARI to study the effect of Gymnocalycium species and different rootstocks on cactus grafting. Hylocereus ×Gymnocalycium grafting combination showed 75% survivality and Echinopsis × Gymnocalycium combination showed 60% survivality. The survivality percentage was highest in C_1S_1 (85%) whereas lowest survivality was in C_1S_3 (31%) The main reasons for death of scion are initial loss of color, eventual dehydration, failure to translocation from scion to stock and necrosis of scion. In case of Echinopsis the combination C_2S_2 showed best grafting compatibility (56%) and C_2S_1 showed minimum compatibility (25%). The continued growth of both stock and scion indicates the successful union of cactus grafting both for Hylocereus(Table 1) and Echinopsis rootstocks. The increasing length and diameter of both stock and scion after 2 months indicates the established grafting and growing as one plant. In case of Hylocereus × Gymnocalycium grafting combination rootstock growth pattern, percentage increase in length and diameter was maximum in C_1S_2 (14.07 and 12.5%) and minimum was in C_1S_3 (3.15 and 2.8%). In addition, Percentage increase of length of scion was maximum in C_1S_2 (12.00%) and minimum in C_1S_1 (0.00%) whereas, maximum increase in percentage of diameter was observed in C_1S_1 (18.75%) and no growth in diameter was observed in C_1S_2 and C_1S_3(0.00 and 0.00%). In case of Echinopsis × Gymnocalycium growth pattern maximum rootstock increase in percentage in length was observed in C_2S_3 (3.7%) and minimum was in C_2S_2 (0.9%). Maximum increase in rootstock diameter was observed in C_2S_2 (8.7%) and minimum was in C_3S_3 (1.56%). Maximum scion length was in C_2S_1 (12.5%) and minimum length was observed in C_2S_2 (3.45%) whereas, and maximum diameter was showed by C_2S_3 (10.52%) and minimum diameter was in C_2S_1 (3.03%). Based on the observation, Hylocereus can be recommended as rootstock in case of grafting combination with Gymnocalycium.

Effect of shading and varieties on growth, flowering and bulb production in lilium flower

The experiment was conducted at Floriculture Research Field, HRC, BARI during November, 2019 to May, 2020 to find out the suitable shade for growth, flowering and bulb production for specific lilium genotypes. Among four levels of shade, black net produced the longest plant (65.50 cm), spike (78.50 cm) and rachis (29.31 cm), maximum number of florets/spike (5.76) and also the largest floret (17.39 cm). Regarding bulb production, black net produced the maximum number of bulbs/plant (1.33), the heaviest and largest bulb (28.73g and 4.69cm, respectively) and also the bulblets production per plant. UV polyfilm also showed significantly similar results with black net in terms of growth, flowering, bulb and bulblet production except spike and rachis length (71.0cm and 25.69cm, respectively). Plants grown under green net and open condition did not performed well. Considering varieties, BARI Lilium-2, a yellow colour variety showed significantly better performances like the longest plant (68.12 cm), spike (81.82 cm), rachis (28.40 cm), the largest floret (17.60 cm) and the maximum number of bulbs/plant (1.33). But BARI Lilium-1, a creamy white variety produced significantly the maximum number of florets (5.53), the heaviest and largest bulb (28.78g & 4.44cm, respectively) and the highest bulblet weight/plant (2.60g).

Effect of pinching on yield and quality of carnation

The experiment was carried out to study the effect of pinching methods on carnation under protected condition during 2019-2020. Experimental results revealed that all the recorded parameters were significantly influenced by methods. Unpinched plants showed significantly maximum plant height while significantly highest number of shoots was observed in double pinched plants. Stalk length of flower, vase life and flowering duration were significantly highest in no pinching whereas double pinching recorded maximum number of shoots and flowers per plant.

Lilium bulb preservation influenced by various temperature and storing media

The experiment was conducted at BADC Cold storage, Kashimpur, Cool room of Postharvest Division, Bangladesh Agricultural Research Institute (BARI) and constant temperature and humidity chamber, HRC, BARI, Gazipur and Floriculture Research Field, HRC, BARI during June, 19 to May, 2020 to find out the optimum storage temperature and suitable storing media for lilium blub preservation. Among three level of storage temperature and three level of storing media, cool temperature (2.1-2.5^{0}c) with sawdust media showed better performances in respect of growth of bulbs during storage period. Considering flower, bulb and bulblet production from bulbs kept at storage, cool temperature (2.1-2.5^{0}c) performed very well. But regarding preservative media, no remarkable significant differences were observed without few exceptions. So, lilium bulbs can be successfully preserved at cool temperature (2.1-2.5^{0}c) with any media like sawdust (100%), cocodust (100%) and the mixture (50:50) of sawdust and cocodust.

Effect of substrates on yield and quality of gerbera in soilless culture

An experiment was conducted at the Floriculture Division of Bangladesh Agricultural Research Institute, Gazipur during winter season of 2019-20 to study the effect of different substrate on growth, flowering, yield and quality of gerbera. Four different potting substrates like soil, cocodust, perlite and sawdust were used in seven combinations. The treatment combinations were T_1: Soil (control), T_2: Cocodust, T_3: Perlite, T_4: Sawdust, T_5: Cocodust + perlite (1:1), T_6: Cocodust + soil (1:1) and T_7: Cocodust + sawdust (1:1). Data on plant growth and flower character like plant height, leave number, plant spread, sucker number, days to flowering, flower number, stalk length, stalk weight, stalk diameter, vase life and flowering duration were recorded. Among the various substrates, cocodust and perlite (T_5) (1:1) as well as cocodust (T_2) singly performed best followed by Cocodust + soil (1:1) T_6 in respect of growth, floral and quality characteristics of gerbera. Contrasting to this, gerbera grown on soil (T_1) alone performed poor result.

Standardization of substrates for lilium bulb production through scaling

The experiment was conducted to find out suitable substrate for propagation of lilium bulb through scaling. Seven combinations of substrates i.e. T_1: sand, T_2: sawdust, T_3: cocodust, T_4: sand + sawdust (1:1), T_5: sand + cocodust (1:1), T_6: sawdust + cocodust (1:1) and T_7: sand + sawdust + cocodust (1:1:1) were used as treatments and outer scales of bulb from Lil-001 were used. Sprouting percentage after 7days of storage, T_1 is best substrate among the others. In case of bulblet production T_4 (sand + sawdust) performed better. Maximum number of leaves were produced by T_5 (1.5). Maximum number of bulblets were produced by T_4 (3.5cm) and minimum were produced by T_2, T_6 and T_7 (1.5cm). In case of weight of bulblets/scale, highest bulblets weight was found in T_4 (4.20g). Maximum sized bulblets were observed in T_4 (11.90mm). Longest root was produced in T_6 (4.01cm) followed by T_1 (4.3cm), T_4 (4.01cm), T_7 (3.91cm) and T_2 (2.46cm). Considering the sprouting percentage after 7days of storage, T_1 (sand) is performed best among the others. In case of bulblet production T_4 (sand + sawdust) performed better.

Determining optimum storage temperature and duration for preservation of lilium flower

The experiment was conducted at the floriculture division research field and Postharvest Technology Laboratory of Horticulture Research Centre, BARI, Gazipur during 2019-20 to find out the optimum temperature and storage duration for preservation of lilium flower. Among three levels of temperature (8^{0}C, 12^{0}C and room temperature (23±1^{0}C) and two storage duration (2 days and 4 days), 8^{0}C temperature with 2 days duration performed best in case of vase life of lilium flowers. Considering the vase life of lilium flower the combination of 8^{0}C temperature with 2 days storage duration had significant influence on vase life enhancement.

Effect of hot water treatment, organic fertilizer and fungicide on seed-borne disease, seed quality and yield of gladiolus

The experiment was conducted at Floriculture division of Horticulture Research Centre, BARI during 2019-20 to study the effect of different biological and chemical measures on seed-borne disease seed quality and yield in gladiolus. Nine treatment combination was used along with control. i.e. T_1: 55˚C for 5 minutes + Mustard oil cake(MOC), T_2: 55˚C for 5 minutes + Autostin drenching, T_3: 55˚ for 5 minutes + Tricho-compost, T_4: Corm soaked with Autostin + Mustard oil cake(MOC), T_5: Autostin + Tricho-compost, T_6: Trichoderma Talc + Mustard oil cake(MOC), T_7: Trichoderma Talc + Autostin drenching, T_8: Trichoderma Talc + Tricho-compost, T_9: Autostin + Autostin Drenching, T_0: Control (Untreated). All treatments performed better than control. Results indicated that the most influenced variables were spike length (cm), rachis length (cm), days to spike initiation, days to 50% spike initiation, floret no./spike, corm diameter, cormel no./hill, cormel diameter, weight of single corm, weight of cormel/hill. Considerdering the rachis length and floret number T_8 (Trichoderma Talc + Tricho-compost) showed better performance than other treatments. If cormels quality is the priority, treatments T_4 (Corm soaked with Autostin + Mustard oil cake), T_5 (Autostin + Tricho-compost) and T_7 (Trichoderma Talc + Autostin drench) rendered superior result.

Effect of Spacing on Yield and Yield Contributing Characters of Gypsophila

An experiment was conducted at the research field of Floriculture Division, HRC, BARI, Gazipur during 2019-20 to determine the suitable plant spacing for maximization of gypsophila yield. The experimental treatment was six plant spacing such as T_1= Farmer practice, T_2= 20 cm × 05 cm, T_3= 20 cm × 10 cm, T_4= 20 cm × 15 cm, T_5= 30 cm × 05 cm and T_6= 30 cm × 10 cm. The blanket doses of fertilizer was 100 kg N ha^{-1}, 40 kg P ha^{-1}, 60 kg K ha^{-1}, 20 kg S ha^{-1}, 3 kg Zn $ha^{-1}$and 1.5 kg B ha^{-1}. The experiment was laid out in randomized complete block design with three replications. The results showed that the highest seed yield (1316 kg ha^{-1}) was obtained from the treatment T_3.The lowest seed yield was found in T_2 treatment. Most of the cases, the performance of yield parameters were found better in T_3 treatment. The economics point of view, the highest net return (Tk. 547253 ha^{-1}) and benefit cost ratio (1.71) was counted from the treatment T_3. The lowest net return and benefit cost ratio was calculated from the T_2 treatment. On the basis of yield and benefit cost ratio, the 20 cm × 10 cm could be suitable plant spacing for gypsophila cultivation.

Adaptive trial of gladiolus varieties at farmers field

Trials were conducted at Gazipur, Jamalpur, Rajshahi, Khagrachori, Bogura and Rangpur during *rabi* season of 2019-20 to observe the performance of gladiolus varieties and to popularize among the farmers. 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 Jamalpur 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, Bogura, Rajshahi and Khagrachori.

Adaptive trial of tuberose varieties at farmer's field

Trials on BARI Tuberose-1 with promising line (PT-001) as check were conducted at Gazipur, Jamalpur, Rajshahi, Khagrachori, Bogura and Rangpur during 2019-20. 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 10 t 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

Trials were conducted at Gazipur, Jamalpur, Rajshahi, Khagrachori, Bogura and Rangpur during summer season of 2019-2020 to observe the performance of BARI released Marigold variety under farmer's field condition. BARI Marigold-1 produced higher yield over local variety at all locations. Farmers are very much interested to cultivate the new variety of BARI Marigold-1 for getting higher yield and better market price at all locations.

Development of Bio-rational management approach against boll worm attacking rose

A field experiment was conducted at farmer's field of VowalGazipur village under Gazipur sadar upazila, during October-2019 to March 2020 to find out an effective bio-rational based management approach against rose bollworm, Helicoverpa armigera. Six treatments, such as: T_1: Mass trapping through installing sex pheromone T_2: Mass trapping through installing sex pheromone + spraying of Azadirachtin (Bio-neem plus 1EC) @ 1ml/L of water;T_3: Mass trapping through installing sex pheromone + spraying of HNPV @ 0.2 g/L of water at 10 days interval;T_4: Mass trapping through installing sex pheromone+ spraying of Spinosad (success 2.5 SC) @ 1.2 ml/L of water at 10 days interval;T_5:Farmers practice (spraying of synthetic insecticides, Proclaim5SG);T_6:Untreated control were evaluated following RCB design with three replications. The results indicated that mass trapping through installing sex pheromone + spraying of HNPV @ 0.2 g/L of water at 10 days interval showed the best performance reducing infestation and increasing marketable yield and maximum marginal benefit cost ratio.

Determining optimum storage temperature and duration for preservation of lilium flower

An experiment was conducted at the floriculture division research field and Postharvest Technology Laboratory of Horticulture Research Centre, BARI, Gazipur during 2019-20 to find out the optimum temperature and storage duration for preservation of lilium flower. Among three levels of temperature (8^0C, 12^0C and room temperature 23 ± 1^0C) and two storage duration (2 days and 4 days), 8^0C temperature with 2 days duration performed best in case of vase life of lilium flowers. This is the first year's treil and the experiment is needed to be continued for confirming the result.

08 CEREAL CROPS

Research progress:

Plant Breeding Division of Bangladesh Agricultural Research Institute (BARI) works for variety improvement of different cereal crops namely, barley, sorghum, millets, oat, buckwheat and quinoa. Minor cereal like barley (*Hordeum vulgare*) is a stress tolerant rabi crop which is best suitable to cope with salinity in south coastal region of Bangladesh. Therefore, collection and evaluation of germplasm, hybridization, and maintenance and seed production is the main activities for variety improvement minor cereals. The endmost objectives are to develop stress resilient high yielding, early and dwarf and nutritionally enriched varieties as well as climate resilient maize. Actually, Plant Breeding Division is constantly working for high yielding and climate resilient varieties. To popularize and disseminate released varieties govt. allied organigation among farmers and private agencies, different activities such as block demonstration, adaptive trials, farmers training, workshop, field days, publications etc. are also being carried out.

Maize improvement

Although the mandate of maize breading has recently been deligated to newly established BWMRI but repot of previously set experiments are compiled to inform the report results of maize as conducted by BARI.

A: Collection, characterization and maintenance of germplasm

Maintenance and seed increase of promising inbred lines of maize

Inbred lines are the primary units for the development of high yielding desirable hybrids. So, maintaining seed purity is the primary task and it must be done with due care. The quality of hybrid seed production greatly depends on seed purity under field condition and post harvest period. Inbred lines are homozygous genotypes produced by repeated selfing with selection over generations.

One hundred and sixteen field corn, thirty seven sweet corn and nine popcorn inbred lines of maize were maintained through selfing by hand pollination. A total of 52.79 kg seed from field corn, 4.92 kg from sweet corn and 2.38 kg seed from pop corn were harvested and preserved separately for future breeding program.

Maintenance and characterization of exotic and locally developed maize inbred lines (3 sets)

Inbred lines are the prerequisite for hybrid development. Characterization of inbred gives us opportunity to identify a particular variety and maintain seed purity by rouging off type plants. A total of 56 inbred lines consisted of 3 sets were evaluated in Gazipur. Each inbred line was selfed by hand pollination, characterized using CIMMYT descriptor and seeds were preserved for future breeding program.

B: Development of source population and inbred lines

Development of base population in maize

Maize breeding is focused to achieve high yielding with stable performance of hybrids. So, development of elite inbred line is the first step which is basically depends on source population development. Balanced bulk of 7th cycle seeds collected from forty nine superior hybrids were selected for dwarf and earliness and planted for random mating in isolation as well as selfing at

BARI, Gazipur during rabi 2019- 20 for the development of source populations. The trial consists of 100 selected ears which were random mated in the previous year. For next cycle of selection and inbred development from desirable plants, finally 215 ears were selected separately from two groups (130 ears from random mating and 85 ears from selfing) which were preserved carefully. The balanced bulked seeds from randomating population and selfed ears will be grown in isolation for selection and inbred development for the desired traits in coming rabi season.

Advancing S_0 to S_7 generation of field corn, popcorn, baby corn and sweet corn

S_0 to S_1: Field corn

Generation advancing through selfing by hand pollination for inbred line development is a routine work in maize breeding. About 300 plants were raised from a commercial hybrid (Mohabir) and 20 healthy and disease free plants were selected and self pollinated. The selected and selfed seeds of 20 ears were preserved separately for advancing them from S_1 to S_2 generation in next year.

S_2 to S_3: Waxy corn

Two sets of S_2 lines extracted from Xiang Waxy corn 2008 and Xiang Waxy corn 932 were advanced from S_2 to S_3 generation in order to develop superior inbred lines. The selected S_3 plants in each set were selfed. Finally, 74 selfed ears from Xiang Waxy corn 2008 and 59 selfed ears from Xiang Waxy corn 932 were harvested. Selected seeds were preserved separately for advancing them from S_3 to S_4 generation in the next year following ear to row method.

$S_3$to S_4: Field corn

The S_3 seeds of field corn hybrid (IM8119) were advanced from S_2 to S_3 generation. Variations were found among the lines for different traits. The selected S_2 plants were selfed by hand pollination and finally 124 selfed ears were harvested. Selected selfed seeds were preserved separately for advancing them from S_4 to S_5 generation in the next year.

S_4 to S_5: Sweet corn

The balanced bulk S_4 seeds of two sweet corn hybrids (14 lines from Dream sweet 2 and 17 lines from Dream sweet 3) were advanced to S_5 generation through selfing by hand pollination. Variations were found among the S_4 lines for different traits under study and finally 79 and 105 selfed ears were harvested from Dream sweet-2 and Dream sweet-3, respectively, and kept them separately for advancing the population for S_6 generation in the next year.

S_5 to S_6: Baby corn and field corn

The balanced bulk S_5 seeds of baby corn hybrid (14 lines from Baby star) and field corn hybrid (25 lines from IM8013) were advanced to S_6 generation through selfing by hand pollination. Variations were observed among the S_5 lines for different traits under study. Selected 70 and 101 selfed ears were collected from baby star and IM8013, respectively, for advancing them from S_6 to S_7generation in the next year

S_6 to S_7: Field corn, popcorn and sweet corn

The S_6 seeds of 156 field corn, 38 popcorn and 26 sweet corn lines were advanced to S_7 generation. Variations were found among the lines for different traits under study. Selected S_6 plants were selfed by hand pollination. In total 31.33 kg, 6.91 kg and 12.62 kg selfed seed were harvested from field corn, popcorn and sweet corn, respectively, and preserved them for future breeding program.

C: Evaluation of inbred lines

Evaluation of inbred lines of field corn through line × tester method

Nineteen lines were crossed with 2 test ers namely BIL79 and BIL157 following Line × Tester mating design in rabi 2018-19 and the resulting 38 crosses along with five checks BARI Hybrid Maize 16, 981, DON111, Mohabir and Miracle were evaluated in a alpha lattice design with two replications, during rabi, 2019-20 at Gazipur. Among them four lines viz. BIL106, BML75, CML 487 & CML 496 were best for having desirable GCA effects for higher yield. Six crosses namely BIL106 × BIL79 (11.7 t/ha), BML75 × BIL79 (12.41 t/ha), BML75 × BIL157 (12.49 t/ha), CML480 × BIL79 (14.52 t/ha), CML487 × BIL157 (11.57 t/ha) and CML 496 × BIL157 (11.51 t/ha), were selected based on their SCA effects for grain yield, yield contributing characters and mean values and per se performances which could be used for commercialization and need for further evaluation in larges plot in next year.

D: Evaluation of single cross hybrids

Combining ability and heterosis in maize (2 Sets)

In Set I, Six diverse inbred lines were crossed in a 6×6 diallel fashion excluding reciprocals in rabi 2018-19 and resulting 15 F_1's along with 5 commercial checks (BARI hybrid maize 16, 981, DON111, Mohabir and Miracle) were evaluated during rabi 2019-20 following alpha lattice design with 2 replications in five locations viz. Gazipur, Jashore, Dinajpur, Barisal and Jamalpur. Among the eight parents, parent P_2 was the best general combiner for yield while parents P_1 and $P_5$for earliness. Two crosses namely $P_1 \times P_4$ and $P_2 \times P_3$ showed highest SCA effects for grain yield indicating that these were best specific combinations for higher grain yield and selected for further evaluation.

In Set II, Seven elite maize inbred lines were crossed in a 7×7 diallel fashion excluding the reciprocals in rabi 2018-19 and resulting 21 F_1's were evaluated along with three checks namely BARI hybrid maize 16, 981 and DON111 in a alpha lattice design with two replications during rabi 2019-20 in three locations viz. Gazipur, Dinajpur and Burirhat. Parents $P_1$was selected as a best combiner for yield; parents P_3, P_4 and P_5 for dwarfness. Among the 21 crosses, four crosses i.e. $P_1 \times P_5$, $P_1 \times P_7$, $P_2 \times P_4$ and $P_4 \times P_6$ showed significant and positive SCA effects for yield. Two crosses namely P1 × P5 (11.6 t/ha) and P5 × P6 (11.1 t/ha) showed high mean yield as well as higher heterosis (10.8% and 6.0% respectively) and can be utilized for developing high yielding hybrid after verifying under different agro-ecological zones.

Evaluation of selected single cross hybrids of field corn, baby corn and pop corn (5 sets)

In Set I, Seven single cross field corn hybrids were evaluated along with three commercial checks viz. BHM-16, 981 and Don 111following Randomized Complete Block Design (RCBD) with three replications. Significant differences were observed among the genotypes for all the characters studied. Considering yield, short stature and earliness three hybrids i.e. 9MG-12 × 9MS-12 (11.8 t/ha) and 9MG-9 × 9MS-14 (11.5 t/ha) and Pac 60-3 × BIL-113 (10.9 t/ha) were found promising and selected for further evaluation across under different ecological zones in the next year.

In Set II, Twenty single cross field corn hybrids were evaluated along with three commercial checks viz. BHM-16, 981 and Don 111following Randomized Complete Block Design (RCBD) with three replications. Significant differences were observed among the genotypes for all the characters studied except days to tasseling, days to pollen shedding and days to silking. Considering yield, short stature and earliness three hybrids viz. Pinacle 10 x 900M6 (11.3 t/ha), 900M4 x E37 (11.2 t/ha) and Pinacle 10 x E37 (10.9 t/ha) were found promising and selected for further evaluation across different agro-ecological zones.

In Set III, Twenty single cross field corn hybrids were evaluated along with five commercial checks viz. BHM16, 981, DON11, Mohabir and Miracle following Randomized Complete Block Design (RCBD) with two replications. Highly significant differences were found for all the studied traits except days to maturity and plant height. Considering yield and yield contributing traits two entries namely E8 (11.1 t/ha) and E18 (10.5 t/ha) were found promising among the tested material and selected for next year evaluation.

In Set IV, Sixteen locally developed baby corn hybrid were evaluated along with one commercial check namely baby star following Randomized Complete Block Design (RCBD) with two replications. Significant difference was found in all the traits except plant height. Considering yield two crosses BCP 271-16 × BCP 271-4 (35.6 g) and BCP 271-10 × BCP 271 -3 (32 g) exhibited high baby cob yield per plant and could be selected for further evaluation.

In Set V, Eight single cross pop corn hybrids were evaluated along with one commercial check Khoibhutta following Randomized Complete Block Design (RCBD) with three replications. Significant differences were observed among the genotypes for some studied characters namely yield, thousand grain weight and popping percentage. Three crosses namely PCB-12×T17 (4.19 t/ha), PCB-13×T17 (4.48 t/ha) and PCB-15×T8 (4.11 t/ha) were found promising and selected for next year evaluation in larges plots.

Evaluation of selected single cross field corn hybrids at different locations (3 sets)

In Set I, One hundred and six single crosses and four check varieties (BHM16, 981, DON111 and Mohabir) were evaluated following alpha lattice design with two replications for genotype environment interaction (GEI) and stability to select promising one(s).The crosses were evaluated at five locations namely Gazipur, Jashore, Barishal, Burirhat, Jamalpur and Dinajpur during rabi 2019-20. The result of the study revealed that environment of Barishal and Jamalpur was less suitable but Gazipur, Jashore and Dinajpur were suitable for hybrid maize cultivation. Considering yield potentiality and stability parameter, hybrids E23 (10.6t/ha), E25(9.7 t/ha), E29(11.14 t/ha), E39 (10.2 t/ha), E41(9.3 t/ha), E76 (9.0 t/ha), E81 (9.4 t/ha), E87(10.3 t/ha) and E88 (10.1 t/ha) exhibited the higher grain yield as well as stable across locations and need to be evaluated further under different agro-ecological zones of Bangladesh.

In Set II, Ninety four crosses and four check varieties (BHM16, 981, DON111 and Mohabir) were evaluated following Alpha Lattice Design with two replications for genotype environment interaction (GEI) and stability to select promising one(s) at four locations namely Gazipur, Jamalpur, Barishal and Rangpur during rabi 2019-20. The result of the study revealed that the environment of Gazipur and Jamalpur were the most suitable for hybrid maize production. Considering yield potentiality and stability parameter, five crosses viz.M-29 (13.0 t/ha), M-31 (12.6 t/ha), M-24 (11.8 t/ha), M-28 (11.6 t/ha) and M-68 (11.6 t/ha) exhibited the higher grain yield as well as stable across locations and need to be evaluated further under different agro-ecological zones of Bangladesh.

In Set III, One hundred twenty two crosses and four check varieties (BHM16, 981, DON111 and Mohabir) were evaluated following Randomized Complete Block Design (RCBD) with two replications for genotype environment interaction (GEI) and stability to select promising one(s) at four locations namely viz; Gazipur, Barishal and Dinajpur during rabi 2019-20. The result of the study revealed that the environment of Barishal was less suitable whereas Dinajpur and Gazipur were the most suitable for hybrid maize production. Considering yield potentiality and stability parameter, three crosses viz. E108 (12.59 t/ha), E101 (12.46 t/ha) and E118 (12.35 t/ha) exhibited the higher grain yield as well as stable across locations and need to be evaluated further under different agro-ecological zones of Bangladesh.

Evaluation of promising field corn and baby corn hybrids at different agro ecological regions (3 sets)

In Set I, Eight promising crosses of field corn and two check varieties (BHM-16 and 981) were evaluated following Randomized Complete Block Design (RCBD) with two replications for genotype environment interaction (GEI) and stability to select promising one(s) at three locations namely Gazipur, Jashore and Dinajpur during rabi 2019-20. The result of the study revealed that the environment of Jashore was less suitable compared to Gazipur and Dinajpur for hybrid maize production. Considering yield potentiality and stability parameter, two crosses viz. E6 (13.4 t/ha) and E2 (12.0 t/ha) exhibited higher grain yield as well as stable across locations and need to be evaluated further in large plots before release as commercial hybrids across different agro-ecological zones of Bangladesh.

In Set II, four baby corn hybrids were evaluated during rabi 2019-20 at three environments viz. Gazipur, Rangpur and Dinajpur, along with one commercial check variety, Baby Star following Randomized Complete Block Design (RCBD) with two replications for genotype environment interaction (GEI) and stability to select promising one(s). The result of the study revealed that the environment of Rangpur found to be the most suitable for baby corn cultivation. Considering high baby cob yield per plant, three hybrids viz.BCP 271 -18 × BCP 271 -16 (37.1 g), BCP 271 -20 × BCP 271 -6(36.8 g) and BCP 271 -18 × BCP 271 -6 (36.1g) exhibited higher yield and were stable over the environment. On the other hand, regarding green fodder yield per plant, BCP 271 -20 × BCP 271 -6 (563 g) and BCP 271 -18×BCP 271 -6 (501 g) were found as promising genotypes and need to be evaluated further in larges plots before release as commercial hybrids across different agro-ecological zones of Bangladesh.

In Set III, Twelve promising crosses and three check varieties (BHM16, 981 and Don 111) were evaluated following Randomized Complete Block Design (RCBD) with three replications for genotype environment interaction (GEI) and stability to select promising one(s) at four locations namely Gazipur, Haihazari, Jamalpur and Dinajpur during rabi 2019-20. The result of the study revealed that the environment of Gazipur, Hathazari and Jamalpur appeared to be less and Dinajpur was rich for hybrid maize production. Considering yield potentiality and stability parameter, three hybrids namely E3 (11.2 t/ha), E8 (11.3 t/ha) and E10 (10.8 t/ha) exhibited higher grain yield as well as stable across locations and need to be evaluated further in larges plots across different agro-ecological zones of Bangladesh.

F. Development of new hybrids

Exploitation of hybrid vigour and selection of parents based on combining ability and *per se* performance has been used as an important breeding approach in crop improvement. Inbred lines are the pre requisite for hybrid development and their worth is considered by their performance in combination with different inbred lines. Combining ability is one of the powerful tools in identifying the best combiner that may be used in crosses either to exploit heterosis or to accumulate fixable genes. Combining ability of inbred lines provides information about genetic nature of quantitative traits and for the selection of most appropriate parents to be used for heterosis breeding. Line x tester method, diallel mating design also provides an opportunity to evaluate the genotypes during development of inbreds.

Seed production of single cross maize hybrids though line × tester method in isolation (2 Sets)

Seventy eight inbred were crossed in isolation with two testers viz. BIL 28 and BIL 211 in two different locations i.e. Bogura and Narshingdi, respectively, during rabi 2019-20. The resulting 156 F_1s will be evaluated in the next rabi season of 2020-21. A total of 52.33 kg seed from set I (crossed with BIL28 at Narsingdi) and 93.34 kg from set II (crossed with BIL211 at Bogura) were obtained from two different locations.

Production of single cross field corn hybrids through diallel mating design

One set of crosses were made following 7×7 diallel fashion at Gazipur during rabi 2019-20. All the crosses (21) produced seeds successfully. A total of 4.94 kg seed was obtained from 21 crosses and will be evaluated in the next rabi season of 2020-21 for selecting promising hybrid(s).

Seed production of selected single cross hybrids of short statured, lodging tolerant, excess soil moisture and saline tolerant field corn and baby corn (4 Sets)

The seeds of selected single crosses from last year trials need to increase further for verifying them in wider agro-ecological zones. A total of17.3 kg seeds of field corn and 16.23 kg seeds of baby corn were obtained from different crosses.

G. Maintenance and seed increase of parental/inbred lines

Inbred lines regarded as potential parental components of hybrids. So, maintaining of inbred lines without any genetic change is an important and careful task. The goal of inbred line maintenance is to maintain the performance, appearance and genetic integrity of the original lines.

Maintenance and seed increase of the parental lines of BARI maize hybrids

Twenty two parental lines of BARI released hybrid varieties were grown at BARI, Gazipur during rabi 2019-20. A total of 10.12 kg seeds were obtained from 22 parental inbred lines. At flowering stage, healthy, disease free plants were selected and selfed by hand pollination. Mature selfed ears were harvested separately and dried properly. Undesirable ears were discarded. A final selection was done after harvest based on grain color, row arrangement and texture and preserved for future breeding purpose.

Seed production of the parental lines of BARI maize hybrids

Parental lines are pre-requisite for hybrid seed production. So, maintenance of parental lines is very important to keep the quality of the respective inbred lines. It is very necessary to produce higher volume of the parental lines for large scale hybrid (F_1) seed production to meet the local demand and to supply seeds to the interested public and private partners for commercialization.

A total of 1235 kg breeder seeds were produced from eight different parental lines of BARI released hybrids at thirteen different locations. Among them 500 kg seeds were obtained from BIL71, 300 kg from BML-59, 50 kg from BML-74, 60 kg from BIL211, 20 kg from BIL28, 350 kg from BIL157, 190kg from BIL79and 5kg from BIL213 which were kept for the next year seed production and distribution

H. Seed Production of BARI released hybrids

High quality seed is the basic and vital input for enhancing maize production and productivity. To popularize the released varieties among farmers, seed production of released varieties 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 experimental purposes.

Seed production of BARI hybrid maize

A total of 2291 kg hybrids seeds of six BARI maize hybrids viz. BARI hybrid maize 9, BARI hybrid maize 13, BARI hybrid maize 14, BARI hybrid maize 15, BARI hybrid maize 16 and BARI hybrid maize 17 were produced at six different locations (Gazipur, Jamalpur, Burirhat Jashore, Debiganj and Dinajpur, Rajbari) with proper isolation (time/space) and maintaining female and male ratio of 4:2. At flowering stage, the plants from female rows were detasseled before pollen shedding and ears were collected from female plants only. Finally harvested ears were sorted, processed and stored for the next year use.

I: Maintenance and seed production of Open-pollinated varieties

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

Maintenance and seed production of BARI composite maize varieties

A total of 575 kg seeds of five composite variety namely Barnali, Shuvra, Khoibhutta, BM-6, and BARI Sweet corn-1were produced at five different locations (Gazipur, Sherpur, Faridpur, Pabna and Pahartoli) with proper isolation(time/space) maintaining female and male ratio of 2:1. At flowering stage, male flowers (tassel) from female lines were detasseled and ears were collected from the female plants only and the harvested ears were sorted, processed and stored them for the next year use.

J: Maize Biotechnology: Molecular breeding

Comparative study on oxidative stress tolerance mechanism in maize (c_4) and barley (c_3) under drought condition

This experiment was conducted with two maize varieties [BARI hybrid maize-13 (BHM-13) and BARI hybrid maize-16 (BHM-16)] as C_4 crop and two barley varieties [BARI barley-8 (BB-8), BARI barley-9 (BB-9)] as C_3 crop to find antioxidative based comparative adaptive mechanism between them. Ten days old seedlings of maize and barley grown on plastic bucket in green house were subjected to water withdrawal untill attain 8% and 4% soil moisture. At 8% and 4% soil moisture data were measured from fully expanded leaves. Substantial higher ROS were observed in barley than maize, although significantly increased ROS were found in maize. Comparatively higher ROS was found in barley as compared to maize under drought. Both SOD and APX played important role in both maize and barley. Genotypic variation was found in maize for CAT and GPX. In spite of higher activity POD showed in maize, higher CAT and GPX could have better role in H_2O_2 metabolism in barley under drought.

K. Technology transfer activities

Comparative yield trial of BARI released and imported maize hybrids at different locations

Twenty imported hybrids and five BARI released hybrids (BHM 7, BHM 9, BHM 13, BHM 16, and BHM 17) were evaluated following RCBD with 2 replications for genotype environment interaction (GEI) and stability to select of promising one(s) at five locations viz. Gazipur, Dinajpur, Jamalpur, Rangpur and Moulvibazar during rabi 2019-20. The AMMI model (additive main effects and multiplicative interaction) and GGE biplot were used to analyze the genotype-environment interactions. The result of the study revealed the environment of Gazipur and Moulvibazar were less suitable and Dinajpur, Rangpur and Jamalpur were found highly suitable for hybrid maize cultivation. Considering the yield potentiality and stability parameter the commercial hybrid viz. Mun4081 (12.15 t/ha), 981(11.95 t/ha) and Eureky (12.18 t/ha) exhibited as high yielding and stable over all environments.

Training, field days on the performance of BARI released maize & minor cereals varieties

Farmers, Government, and NGO personnel were trained to make them familiar with the new varieties of maize and minor cereal (barley, sorghum and millets) varieties, modern crop management practices, seed preservation techniques and mechanization in cultivating crops. For quick dissemination of new varieties and improved production technologies, a number of technology transfer programs were conducted during 2019-20.

Plant Breeding Division BARI arranged 1 batch training for SAAO, SSA and SA (each with 30 participants), 31 batches (930 participants) training for farmers on hybrid maize production technology, 2 batches (60 participants) training for upazilla and district level officers of DAE, and NGO officers, BARI scientists on hybrid maize production technology, 2 batches (40 participants) training for BADC, private seed companies personnel and BARI scientists on hybrid maize production technology, 5 Batches (150 participants) training for farmers on minor cereal crop production technology and 1 batch (20 participants) training for LA on improvement of skillness training. Four field days on maize and two field days on minor cereals were also conducted in collaboration with OFRD at five different areas of Bangladesh.

Barley, Millets and Sorghum Improvement

A. Barley variety development

Hybridization of barley

Hybridization is the most unique way to create new variability with desirable recombinants from existing diversed sources. To develop early, dwarf, drought and saline tolerant and high yielding hull-less barley variety. Ten parental genotypes (variety and advanced lines) were crossed following half diallel fashion. Among the 45 cross combinations, 42 successfully produced 1449 seeds which have been preserved and will be grown for confirmation trial in the next year.

Confirmation of f_1 generation of barley (2 sets)

Two studies to confirm the F_1 population and to identify the better cross combinations obtained from two sets of diallel crosses (10×10 and 7×7) of barley were conducted with parents and their F_1 progenies. Variations were observed between the genotypes for most of the traits studied. Analysis of better parent heterosis revealed 13 crosses from Set-I and 11 crosses from Set-II showed positive and significant heterosis over better parents for yield/plant. The extent of better parent heterosis for yield ranged from -42.28% (P1×P6) to 59.32% (P4×P8) and for tiller/plant ranged from -14.23% (P4×P6) to 20.77% (P7×P8) in Set-I. On the other hand, heterosis for grain/plant ranged from -25.42% (P3×P7) to 31.56 % (P5×P6) and for tiller/plant ranged from -8.33% (P4×P5) to 8.15% (P2×P6) in Set-II. Thirteen crosses (22.1to39.6 g/plant) from Set-I and 11 crosses (21.3to25.5 g/plant) from Set-II with positive heterosis (4.64% to 59.32%) for yield and negative heterosis (-21.16% to-3.57%) for days to heading were selected for the next year trials.

Performance of f_2, f_3, f_4 and f_6 generation of barley

Success of a hybridization program depends on carefully handling of segregating materials. The main objectives of handling segregating generations is to grow and select the desirable families and individual plants in different filial generation for further evaluation. During selection based on earliness, short stature, hull-less and high yield of barley in different segregating generations, selected bulk method was followed. In F_2 generation, 52 plants from 13 crosses; in F_3 generation, 54 plants from 18 crosses; in F_4 generation, 3 families from 3 families; and in F_6 generation, 9 families from 9 families were selected.

Evaluation of barley germplasm for early and high yield

Twenty previously screened hull-less barley lines received from ICARDA along with three standard checks viz. BARI Barley-7,BARI Barley-8 and BARI Barley-9 were evaluated to select better performing early, dwarf and high yielding hull-less barley lines. Significant variations were observed and six lines viz. IBON-HI-19/E3 (2.4 t/ha), IBON-HI-19/E24 (2.5 t/ha), IBON-HI-19/E43 (2.4 t/ha), IBON-HI-19/E-75 (2.3 t/ha), IBON-HI-19/E-100 (2.5 t/ha) and IBON-HI-19/E-47 (2.6 t/ha) were selected considering short stature, yield and yield contributing characters from 20 barley lines for the next year trial.

Preliminary yield trial of hull-less barley

Eleven genotypes along with one check variety of barley were assessed for genotype environment interaction (GEI) and stability to select the best barley lines in three different locations (Gazipur, Jamalpur and Burirhat). The AMMI (additive main effect and multiplicative interaction) and GGE Biplot model were used to estimate the genotype-environment interaction and their graphical presentation over three locations to select the barley lines having higher yield and other potential attributes. The analysis of variance revealed that environment was greatly responsible for the variations of the traits under studied while both genotypes and genotypes-environments interaction explained very little variation. Considering the mean, bi and S^2di for grain yield, it was evident that all the genotypes showed differential response of adaptability under different environmental conditions. The genotype G4 (3.32 ton/ha) and G10 (3.01 ton/ha) are high yielding and more stable to environmental change on the other hand G1 (3.14 ton/ha), G2 (3.13 ton/ha) and G11 (2.62 ton/ha) exhibited stable over all environments.

International hull less barley yield trial

The experiment was conducted to select better performing exotic barley lines in Bangladesh. Considering earliness, yield and yield contributing characters seven lines (ISB-20001/E129 -2.5 t/ha, ISB-20002/E2 -2.4 t/ha, ISB-20004/E4 -2.4 t/ha, ISB-20006/E6 -2.4 t/ha, ISB-20012/E12 -2.3 t/ha, ISB-20010/E10 -2.2 t/ha and ISB-20022/E136 -2.5 t/ha) were selected from the 138 barley lines for future breeding program.

International barley observation nurseries-high input (IBON-HI)

One hundred and fifty six lines of barley including 4 checks (BB-6, BB-7, BB-8 and BB-9) were evaluated at Gazipur to select better performing exotic barley lines in Bangladesh. Considering earliness, yield and yield contributing characters 12 lines viz. IBON-HI/19/E-111 (2.95 t/ha), IBON-HI/19/E-22 (2.89 t/ha), IBON-HI/19/E-33 (2.95 t/ha), IBON-HI/19/E-87 (2.91 t/ha), IBON-HI/19/E-32 (2.95 t/ha), IBON-HI/19/E-103 (2.89 t/ha), IBON-HI/19/E-54 (2.98 t/ha), IBON-HI/19/E-102 (2.9t/ha), IBON-HI/19/E-119 (2.94 t/ha), IBON-HI/19/E-55 (2.95 t/ha), IBON-HI/19/E-78 (2.94 t/ha) and IBON-HI/19/E-28 (2.95 t/ha) were selected for future breeding program.

Global spring barley yield trial for low input condition (GSBYT)

Twenty four barley lines received from ICARDA along with one standard check BARI Barley-8 were evaluated to select better performing early, dwarf and high yielding barley lines. Significant variations were observed for all the traits among the tested entries except days to maturity, spike length and 1000- grain weight. Considering short stature, yield and yield contributing characters one line, GSBYT/19/E-22 (2.36 t/ha) was selected for next year trial.

B: Millets and Sorghum Variety Development

Evaluation of foxtail millet germplasm

The experiment was conducted to evaluated twenty foxtail millets lines along with one check variety

(BARI Kaon-2) to select better performing early, dwarf and high yielding foxtail millets line and increase seeds of the selected lines. Significant variations were observed for all the traits among the tested entries except 1000 grain weight and yield per plot. Considering short stature, per plot yield and yield contributing characters twelve lines viz. E3 (950 g), E4 (570 g), E6 (685 g), E7 (820 g), E8 (515 g), E9 (725 g), E11 (491 g), E12 (925 g), E13 (495 g), E16 (718 g), E18 (695 g) and E19 (470 g) were selected for the next year trial.

Large plot yield trial of finger millets

A combined analysis was carried out for grain yield, days to heading and maturity, plant height, tillers/plant, panicle length, and yield across three different locations viz. Rangpur, Gazipur and Jamalpur to find out the suitable genotypes across the environments. Analysis of variance for different characters showed the presence of genetic variability among the lines. Considering overall mean grain yield across the locations two genotypes *viz*. IE-501 (5.2 t/ha) and IE-2043(4.49 t/ha) performed across locations.

Advanced yield trial of pearl millet germplasm

A combined analysis was carried out across three different locations viz. Jamalpur, Gazipur and Rangpur to find out the suitable genotypes for grain yield, days to heading and maturity, plant height, tiller/plant, spike length, weight of individual panicle and thousand grain weight. Analysis of variance for different characters showed the presence of genetic variability among the lines. Considering overall mean grain yield across the locations IP3706 produced the highest yield (3.1 t/ha) followed by IP5711 (3.06 t/ha) and IP13523 (2.85 t/ha), whereas IP5793 exhibited the lowest (2.74 t/ha) yield which are statistically similar. So, considering overall mean yield and other desirable characters all exotic pearl millet germplasm i.e., IP3706, IP5711, IP13523 and IP5793 were selected for regional yield trial in the next year.

Multilocation trial of selected ICRISAT sorghum lines

A multilocation yield trial was carried out to observe the performance of grain yield and other yield contributing characters with eight advanced sorghum lines across three diverse locations viz. Gazipur, Noakhali and Shatkhira. The study aimed to confirm the performance of sorghum lines selected from last year trial. The results obtained from three locations were brought under combined analysis. It was observed that, there was significant variation for all the traits over locations except weight of individual panicle and 1000 seed weight among the tested entries. Considering the mean yield and other desirable characters three lines viz. E6 (2.38 t/h), E7 (2.15 t/h) and E8 (2.2 t/h) were found suitable and will be eveluated further across locations.

Large plot yield trial of proso millet germplasm *(Panicumm iliaceum* L.)

The present study assessed genotype × environment interaction and stability for days to heading, days to maturity, plant height, tiller per plant, panicle length, weight of individual panicle, thousand grain weight and grain yield with seven prosomillet germplasm across three different locations of Bangladesh. The AMMI model and GGE Biplot were used to analyze the genotype-environment interactions over locations to select the hybrid having higher yield and other potential attributes. Analysis of variance for yield at three environments indicates that the effects of genotype, environment and their interaction were non significant. Interaction G×E mean sum of squares were non significant for all the character studied. The environment of Burirhat was not so congenial; but Gazipur and Jamalpur found suitable for prosomillet production. Gazipur was found highly suitable for prosomillet cultivation followed by Jamalpur. Considering the mean, bi and S^2di, all the genotypes showed different response of adaptability under different environmental conditions. Considering the yield potentiality and stability parameter three entries viz. BD-1447(2.141 t/h), BD-777(2.146 t/h)and BD-1411(2.136 t/h) exhibited high yield as well as stable over all environments which could be considered to release as variety/varieties and here need to be further evaluated in larges plots under wider agro ecological zones.

C: Buckwheat and Oat Variety Development

Evaluation of buckwheat germplasm

Four genotypes of buckwheat received from PGRC, along with one check Bog-1 collected from Bogura were evaluated to select better performing lines.

Significant variations were observed for days to 50% flowering, days to maturity, number of flower cluster, number of cyme-plant, plant height (cm), number of grain setting, receme/plant, grain/receme, total grain/plant, and 100 seed weight (g), seed yield/plot (g) and seed yield (kg/ha) indicating the existence of adequate variability. Considering yield and yield contributing characters E_3 (647.7 kg/h) was found promising and will be evaluated further in the next year.

Regeneration of oat germplasm

Two genotypes of oat BOL-1and BOL-2 received from PGRC, BARI and Jamalpur, respectively, were grown to increase seed. As a self pollinated crop, these lines were maintained by natural selfing and a total of 122kg seed was produced and preserved for future breeding program.

Collection and maintenance of quinoa germplasm

One genotype of quinoa namely QU1S2514 was maintained in open pollination and a total of 3 kg seed was produced and preserved for future breeding program

D: Seed Production

Breeder seed production of barley

To maintain the purity of the released barley varieties, a total of 1152 kg of breeder seed from five barley varieties viz. BARI Barley 5, BARI Barley 6, BARI Barley 7, BARI Barley 8 and BARI Barley 9 were produced at four different locations.

Breeder seed production of millets and sorghum

Breeder seed is essential for maintaining purity of the variety. A total of 936 kg breeder seed of four BARI kaon, one cheena, one sorghum varieties and two oat lines were produced at four different locations.

E: Minor Cereals Biotechnology: Molecular biology

Comparative study on oxidative stress tolerance in sorghum (c_4) and barley (c_3) crops under drought condition

Antioxidative capacity between sorghum, IS-19153 and IS-21891, and barley, BARI barley-8 (BB-8) and BARI barley-9 (BB-9), was studied with ROS and their metabolizing enzymatic antioxidants analysis. Ten days old seedlings of maize and barley grown on plastic bucket in green house were subjected to water withdrawal until attain 8% and 4% soil moisture. A distinguished and significant difference was found in O2•− generation rate between sorghum and barley, being stronger in barley. For H_2O_2, significant higher content was also found in sorghum, but not so high like O2•−. SOD and APX played important role in both sorghum and barley. CAT can predominantly role in H_2O_2 metabolism while POD was important in sorghum. On the other hand, GPX was genotype depended in sorghum.

Screening of barley genotypes against spot blotch

Eighteen genotypes of Barley (*Hordeum vulgare* L.) were screened for spot blotch disease caused by *Bipolari s*under natural condition to find out resistance genotype. Among the 18 tested genotypes only one genotype i.e. Atalpha showed resistant reaction against barley spot blotch. Five genotypes (Esmardala, E3, Inbon, BHL-29 and BB-5) showed moderately resistant reaction, two genotypes (BHL-27 and BB-8) showed moderately susceptible and rest of the genotypes showed susceptible to spot blotch disease during crop season.

Validation of promising selected proso millet lines under rainfed condition

A combined analysis was carried out for grain yield, days to heading and maturity, plant height, tillers/plant, panicle length, panicle weight and thousand grain weight of ten proso millet germplasm including one check BARI Cheena 1 (Tusher) across three different locations viz. Rajshahi, Gazipur and Gaibandha to find out the suitable genotypes across the environments. Analysis of variance for different characters showed the presence of genetic variabilities among the lines. Considering overall mean grain yield across the locations three lines viz. BD-1488 (2.87 t/h), BD-791 (2.72 t/h), BD-1402 (2.63 t/h) andBD-1446 (2.49 t/h) were relatively high yielder. Gaibandha was as found the most suitable environment for proso millet cultivation.

09 AGRONOMY

Nitrogen use efficiency in maize through different application method

The field experiment was conducted at Agronomy Research Field, Joydebpur, Gazipur of Bangladesh Agricultural Research Institute during *rabi* season of 2019- 2020 to evaluate the efficiency of USG in comparison surface and band application with prilled urea and also to determine the optimum dose of USG. Treatments included in the experiment were: F_1= Recommended fertilizer (RF)with prilled urea, F_2= USG through applicator (80% N), F_3= Band application (80% N) with prilled urea, F_4= USG through applicator (100% N), F_5= Band application (100% N) with prilled urea and F_6= RF except N (RF-N).The experiment was laid out in a randomized complete block design with three replications and the unit plot size was 6m × 5m. Hybrid maize (BARI Hybrid maize-16) was used in the experiment. Seeds were sown on 6 December, 2019. The seeds were treated with provax @ 3 g/kg seed before sown. Fertilizers expect urea were applied at the rate of 60-120-45-4-1.6 kg/ha of P, K, S, Zn, B (Ahmmed *et al*., 2018) as triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid. Whole amount of TSP, MoP, gypsum, zinc sulphate and boric acid were applied as basal. Nitrogen was applied as per treatment. In the experiment, 100% recommended N (225 kg/ha) was used. In treatment $F_{1,}$ 1/3rd pilled N was applied as basal. Remaining 2/3rd N was top dressed at 30 and 50 days after sowing (DAS) of maize. In treatment F_2 and F_4 whole USG at the rate of 80% N and USG 100% N, respectively, were applied through applicator at 20 DAS. In treatment F_3 and F_5, 1/3rd prilled N (80% N) and (100% N) respectively, were applied as basal through band method. Remaining 2/3rd N was applied in two splits at 30 and 50 DAS as band application in both treatments. Data on growth parameters like leaf area and dry matter accumulation were measured at different dates with 15 days interval. Different nitrogen form and dosethrough different application method distinctly differed in leaf area index (LAI), total dry matter production (TDM), light transmission ratio (LTR), crop growth rate (CGR), yield and yield components and nitrogen use efficiency (N_{UE}) of hybrid maize. USG (100% N) applied through applicator produced the maximum TDM and LAI followed by USG 80% N. These parameters finally contributed to higher grain yield. The highest grain yield (9.80 t/ha) was found when USG (100% N) applied through applicator which was statistically identical with USG (80% N). The highest nitrogen use efficiency (N_{UE}) of 19.72 kg/kg was recorded in USG (80% N) treatment followed by USG (100% N). The results revealed that among the different nitrogen form through different application method, performance of USG (80% N application through hand applicator) was better in respect of yield, N_{UE} which saving 20% N for maize cultivation.

Light interception, chlorophyll content and productivity of baby corn as influenced by planting geometry and fertilizer management

A field experiment was conducted during *rabi* season of 2019-2020 to evaluate the influence of crop geometry and fertilizer levels on light interception, chlorophyll content and yield of babycorn. Three plant spacing viz, S_1=40 cm × 20 cm (1,25000plants/ha), S_2= 50 cm × 20 cm (100000 plants/ha) and S_3 =60 cm × 20 cm (83333plants/ha) and three fertilizer doses viz, F_1 = 150- 30- 50- 25-3. 5- 1.5 kg /ha NPKSZnB (Recommended fertilizer dose for babycorn), F_2 = F_1 + 25% NPK and F_3 = F_1 + 50% NPK, were used as treatments. There were 9 treatment combinations as follows: $S_1\times F_1$, $S_2\times F_1$, $S_3\times F_1$, $S_1\times F_2$, $S_2\times F_2$, $S_3\times F_2$, $S_1\times F_3$, $S_2\times F_3$ and $S_3\times F_3$. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 4 m × 3.6 m. Seeds of BARI Baby corn-1 were sown on 12 December 2019. Fertilizers were applied as per treatments. One-third of nitrogen (Urea) and full amount of triple super phosphate (TSP), muriate of potash (MoP), zinc sulphate and boric acid were applied at the time of final land preparation. The remaining N (Urea) was top dressed in two equal splits at 25 DAS and 45 DAS, respectively and mixed thoroughly with the soil as soon as possible for better utilization. A light irrigation was given after sowing of seeds for uniform germination. Two irrigations were done at 30 and 45 DAS. Thinning's were done at 10 DAS and weeding at 15 and 25 DAS. Results revealed that planting geometry and fertilizer levels showed great influence on leaf area index (LAI), light interception, dry matter production and yield of babycorn. LAI was the highest with the population of 125000 /ha receiving N_{225} P_{45} K_{75} kg/ha and light absorption was maximum when most of densely populated plant received the highest amount of N_{225} P_{45} K_{75} kg/ha along with recommended SZn. Response of soil-plant-analysis development (SPAD) value to planting geometry and fertilizer levels was found significantly varied. Plants grown with 40 cm × 20 cm spacing (125000 plants/ha) with recommended ferltilizer dose + 50% N- P- K of RF i.e. gave the highest dehuskedcob yield (3.42 t/ha)which was followed by 40cm × 20 cm (1,25000 plants/ha) with recommended ferltilizer dose + 25% N-P-K of RF and the lowest dehusked cob yield 2.32 t/ha was obtained from plant spacing was 60 cm × 20 cm (83,333 plants/ha) with recommended fertilizer dose. Though S_1F_3 combination gave the highest gross return (Tk.184730.00/ha) but highest benefit cost ratio (2.19) was recorded in S_1F_2 treatment. The overall results indicated that 125000 plants/ha with fertilizer dose of $N_{187.5}$ $P_{37.5}K_{62.5}$- S_{25}-$Zn_{3.5}$-$B_{1.5}$ kg /ha might be economically feasible for baby corn production.

Yield and quality of newly released sweet potato varieties as influenced by integrated nutrient management

The experiment was carried out at the Research Field of Agronomy Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during two consecutive rabi seasons of 2018-19 and 2019-20 to find out the suitable nutrient management of sweet potato for higher productivity. The treatments were T_1=STB fertilizer dose (100-40-100 NPK kg/ha) + BARI SP -8, T_2= STB fertilizer dose (100-40-100 NPK kg/ha) + 20% NPK + BARI SP-8, T_3= STB fertilizer dose (100-40-100 NPK kg/ha) + Vermi compost (3 t/ha) + BARI SP -8, T_4= STB fertilizer dose (100-40-100 NPK kg/ha) + Poultry manure (3 t/ha) + BARI SP -8, T_5=STB fertilizer dose (100-40-100 NPK kg/ha) + BARI SP -12, T_6= STB (100-40-100 NPK kg/ha) fertilizer dose + 20% NPK + BARI SP -12, T_7= STB(100-40-100 NPK kg/ha) + Vermi compost (3 t/ha) + BARI SP -12, T_8= STB (100-40 -100 NPK kg/ha)+ Poultry manure (3 t/ha) + BARI SP -12. Significant variations were observed in tuber yield of sweet potato among the treatments. Higher tuber yield (31.67 t/ha during 2018-19 and 33.94 t/ha during 2019-20) was recorded in T_6 {STB fertilizer dose (100-40 -100 NPK kg/ha) +20% NPK +BARI SP -12 } treatment which was followed by T_8 {STB (100-40-100 NPK kg/ha) + Poultry manure (3 t/ha) + BARI SP -12} treatment. The trial was set up in randomized complete block design with three replications. The unit plot size was 3 m × 3 m. Fertilizers were applied as per treatments in the form of Urea, Triple super phosphate (TSP), Muriate of potash (MoP) Gypsum, zinc sulphate and Boric acid, 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 DAS followed by irrigation. A light irrigation was given after planting for uniform establishment. Vines of sweet potato were planted on 30 November 2018 and 02 December 2019 with spacing 60 cm × 30 cm. The crop was harvested on 29 March 2019 and 18 April 2020. Quality characters of tubers such as firmness, total sugar (Moorthy and Padmaja, 2002) and β-carotene (Goodwin, 1980) were analyzed after harvest at the Post Harvest Technology Division, BARI, Gazipur. Yield and yield contributing characters were recorded and analyzed statistically and mean separations were done by LSD test at 5% level of significance. Dry matter, starch, and β-carotene content were higher with the application of organic manures. The highest gross return (Tk 158350/ha during 2018-19 and Tk.203640/ha during 2019-20) and gross margin (Tk. 138790/ha) were observed in T_6 treatment followed by T_8 and the highest BCR (3.03 during 2018-19 and 3.39 during 2019-20) was obtained from T_8 followed by T_7 treatment. Results showed that STB fertilizer dose+20%NPK + BARI SP -12 produced better yield and less TSS but STB (100-40 -100 NPK kg/ha) + Poultry manure (3 t/ha) + BARI SP -12 gave reasonable good yield and quality of sweet potato.

Effect of growth regulator on onion in beel area of Faridpur

The experiment was conducted at farmers' field in Beel area (Monglar Beel) of Faridpur region. The experiment was laid out in a RCB design with three replications during *rabi*season of 2019-2020. Treatments were *viz*., Litosan, Miraculan, Biofallplus, Bioferti, Bumperfalon, PGR and control. The experiment was laid out in a RCB design with three replications during *rabi* season of 2019-2020. The 47 day old seedling of BARI Piaj-4 was planted on 5 January and harvested on 1-5 April 2020. Growth regulators were applied at 35 and 50 days after planting. The highest bulb yield (20.17-21.39 t/ha) obtained from Miraculan, Bioferti and PGR treated plots. The highest individual bulb weight (50-53 g) was also obtained from these growth regulators treated plots. Miraculan, Bioferti and PGR produced 26-35% higher bulb yield of onion. These three growth regulators enhanced field duration 4-6 days. Miraculan, Bioferti and PGR gave higher gross return (Tk. 705950-748650/ha), gross margin (Tk. 352900-395920/ha) and BCR (2.00-2.12). Farmers' are reluctant to cultivate BARI Piaj-4 due to its non-attractive colour, longer size and low market prize but they wish to use growth regulators for getting higher yield.

Grain and fodder yield of sorghum as affected by cutting time

The experiment was conducted at the Research Field of Agronomy Division, BARI, Gazipur, Joydebpur during *rabi* season of 2019-20 to find out proper cutting time fodder and grain yield in sorghum and the effect of cutting time on sorghum yield components. There were nine treatments in this study viz., T_1= no cutting, T_2 =cutting whole plant at 55 DAS for fodder purpose, T_3 = Keeping main tiller then all tiller cut at 55 DAS for fodder purpose T_4=Cutting whole plant at 70 DAS for fodder purpose, T_5 =Cutting plant 8″ up from ground level at 70 DAS for fodder purpose , T_6=Keeping main tiller then all tiller cut at 70 DAS for fodder purpose, T_7 =Keeping main tiller then all tiller cut at 80 DAS for fodder purpose T_8=Cutting whole plant at 80 DAS for fodder purpose T_9 =Cutting plant 8″ up from ground levelat 80 DAS for fodder purpose. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 3 m x 3 m. Seeds of Sorghum were sown on 27 November 2019. Sorghum seeds were sown at a spacing of 60 cm between rows and 10 cm between the plants. Fertilizers were applied at the rate of 120-48-75-30-3-1 kg/ha of N, P, K, S, Zn, B as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphate and boric acid for sorghum. One third of N, whole amount of TSP, MoP, gypsum, zinc sulphate and boric acid were applied as basal. Remaining 2/3rd N was top dressed at 25 and 45 days after sowing (DAS) of sorghum. A light irrigation was given after sowing of seeds for uniform germination. Two irrigations were done at 30 and 45 DAS. Thinning was done at 10 DAS and weeding at 15 and 25 DAS. The results indicated that cutting time significantly affected sorghum plant height, number of leaf, fresh weight per plant and fodder yield. Fodder yield increased with increasing cutting time. Cutting sorghum at 55, 70 and 80 DAS resulted in re-growth that eventually produced both fodder and grain. Significantly the highest fodder yield (25.33 t/ha) was recorded in cutting whole plant at 80 DAS for fodder purpose. Significantly the highest seed (3.90 t/ha) yield was recorded in no cutting treatment which was followed by keeping main tiller then all tiller cut at 55 DAS for fodder purpose but seed yield reduction was 7.09% over control. From the results it could be concluded that keeping main tiller then all tiller cut at 55 DAS may be chosen for fodder purpose and might be harvested at 55 DAS with slight reduction in seed yield for getting dual purpose of fodder yield and seed yield of sorghum in Gazipur region.

Effect of planting time and variety on the growth and yield of tomato

The experiment was conducted at the RARS, Jamalpur during *rabi* 2019-2020 to find out the suitable planting time and increase production and economic return. Tomato variety viz., V_1 = BARI Tomato-14, V_2 = Udyan were considered as factor A and five planting dates viz., S_1 = 25 August, S_2 = 15 September, S_3 = 05 October, S_4 = 25 October, S_5 = 15 November considered as factor B. The experiment was laid out in RCBD (Factorial) with three replications. The unit plot size was 3m × 2m with the spacing of 60 cm × 40cm. Fertilizers were applied at the rate of 120-454-55-20-1.5-1 kg/ha of NPKSZnB (Ahmmed *et al*., 2018) as urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, zinc sulphat and boric acid. All of P, S, Zn and B were applied as basal during land preparation. N and K were applied in two equal splits at 15 and 35 DAT as ring method under moist condition. Seedlings were transplanted on August 27, 2019 (1st transplant), September 22, 2019 (2nd transplant), October 06, 2019 (3rd transplant), October 28, 2019 (4th transplant) and November 17, 2019 (5th transplant) in rows. Weeding was done when necessary. Tomatos were harvested from January 05, 2020 to March 03, 2020. The yield of tomato was significantly affected by different planting dates and tomato verities. Udyan and BARI Tomato-14 at 25 October and 05 October were suitable combinations for maximum yield of tomato. These combinations might be profitable in case of early growing and proper market price.

Effects of different chemical treatments of murta cane on the quality of *Shital Pati* in Bangladesh

The experiment was conducted from 15 May to 17 July, 2020 at Kamdebpur village under Nalchity upazila of Jhalakati district to develop suitable chemical treatment for improving the quality of shitalpati in Bangladesh. The treatment of the experiment was seven type of chemical treatment/process of murta cane viz., T_1 = Boiled with Tamarind leaf + Cowa leaf, T_2 = Soaking and boiled with fermented rice mud, T_3 = Boiled with white vinegar (vinegar: water = 1:4), T_4 = Boiled with Tamarind/cowa leaf + Vinegar, T_5 = Boiled with Detergent /Bleaching powder, T_6 = Boiled with Fermented rice mud + Arrowroot, T_7 = Boiled with Tamarind leaf + Cowa leaf + Rice mud, T_8 = Boiled with Rice mud + Fermented milk, and T_9 = Control (no treatment). The design of the experiment was Completely Randomized Design (CRD) with three replications. Data were collected on quantitative (surface temperature) and qualitative (brightness, surface glossiness, surface smoothness and relax) traits of shitalpati. The qualitative data were evaluated by using 1 to 7 scale ratings (1 = Excellent quality, 2 = Very good, 3 = Good, 4 = Moderate, 5 = Poor, 6 = Very poor, and 7 = Not useable/worst quality) just after weaving the shitalpati. The chemical treatment of murta cane created variation in quantitative and qualitative traits of shitalpati. The treatment T_7 showed the lowest temperature (30.3 ^{0}C) of shitalpati surface but the highest value (31.0 ^{0}C) was recorded in the control (no chemical treatment) at 4:30 PM on 17 July 2020. In terms of qualitative traits, the average rating of the chemical treatment of T_8 (Boiled with Rice mud + Fermented milk), T_4 (Boiled with Tamarind/Cowa leaf + Vinegar), and T_7 (Boiled with Tamarind leaf + Cowa leaf + Rice mud) were found good qualityof shitalpati. Chemical treatments of T_3, T_5, and T_9 produced Moderate to Poor qualities of shitalpati. However, the experiment should be repeated in the next three years for making final recommendation.

Effect of seedling age on yield of transplanted sunflower under zero tillage condition in southern region of Bangladesh

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during Rabi seasons of 2018-2020 to find out the optimum age and type of sunflower seedling for getting higher yield under zero tillage condition in the southern region of Bangladesh. In 2018-2019, the treatments of the experiment were five ages of sunflower seedlings viz., A_1 = 7-day old, A_2 = 14 day old, A_3 = 21 day, A_4 = 28 days old seedling, which were transplanted under zero tillage conditions, and A_5 = Direct seeding was done under conventional tillage condition. In 2019-2020, the treatments were of two factors, viz., Factor A: Type of seedling: 2 (T_1 = Seedbed seedling, and T_2 = Water hyacinth ball seedling); Factor B: Age of seedling: 4 (A_1 = 7-day old seedling, A_2 = 14-day old seedling, A_3 = 21-day old seedling, and A_4 = Direct seeding). The seedlings were transplanted under zero tillage condition just after harvest of T.aman rice. The experiment was laid out in randomized complete block design with three replications. The variety of sunflower was BARI Sunflower-2. In 2018-2019, experimental results showed that the seedling age had significant effect on plant height, head diameter, number of seed/head and seed yield. Field duration became the lowest (97 days) in 28 days old seedling. The highest field duration (134 days) was found in direct seeding. Field duration reduced gradually with increasing the age of seedlings. Transplant of 14 days seedling gave the highest yield of seed (2017 kg/ha) followed by 7 days seedling (1987 kg/ha). Besides, 21 days seedling produced the yield of 1660 kg/ha. Experimental results further revealed that transplant of 14 days, 7 days and 21 days old seedlings increased the seed yield 30.01%, 28.08% and 6.95%, respectively over the direct seeding of sunflower under conventional tillage condition. In 2019-2020, the effect of seedling age was found significant variation on plant population, plant survivability, days to 50% flowering, days to maturity, plant height, head diameter, number of seed/head and seed yield. Seedling of 21-day old showed the highest survivability rate (93.96%) that was statistically at par to 14-day (93.75%) and 7-day seedling (91.77%). The longest time to maturity (112.33 days) was in direct seeding and 21-day seedling required the shortest time (100.67 days) to maturity. The highest yield (3389 kg/ha) was recorded in 7-day seedling and it was at par to 14-day seedling (3198 kg/ha). Direct seeding crop produced the lowest yield (1937 kg/ha). Seed yield increased 74.94%, 65.09% and 38.32% through transplanting of 7-day, 14-day and 21-day seedlings over the direct seeding crop. The gross return and gross margin were the highest in water hyacinth ball seedling of 7-day old followed by 14-day seedling of the same type. Sunflower could be cultivated through transplanting of 7-14 days old seedbed and water hyacinth ball seedlings under zero tillage condition just after harvesting of T.aman rice in southern region of Bangladesh. Experiment on seedbed and water hyacinth ball seedlings were conducted in the first year (2019-2020) and therefore final recommendation will be made by repeating the experimentation in the next year.

Effect of different concentration and application time of gibberalic acid on growth and yield of potato

The experiment was conducted to find out the appropriate application time and GA_3 concentration for maximizing seed potato production in Bangladesh by increasing seed tuber number per plant and yield at the research field of Agricultural Research Station, Rajbari, Dinajpur, during 2019-2020. Date of sowing was 16 November 2019. In the treatment, different application time of GA_3 was used as Factor A: i.e. A_1=Just after desprouting of seed, A_2=At 30 days after planting (DAP) (seedling stage), A_3=At 45 DAP (vegetative growth stage) and A_4=At 60 DAP (maturity stage). The Different concentration of GA_3 were used as factor B; i.e. G_1 = 00 ppm (without GA_3), G_2 = 20 ppm, G_3 = 40 ppm and G_4 = 60 ppm. The experiment was laid out in RCBD with 3 replications.The unit Plot size was 2.4 m × 4.0 m and line to line distance was 60 cm and plant to plant distance was 25 cm. The application of GA_3 affected the emergence (%) at 12 DAP, the number of tuber per plant and tuber weight per plant and yield. Application of GA_3 (20 to 40 ppm) in seed tuber or in seedling of potato could increased the number of tuber per plant and also yield. Application of GA_3 (20 to 40 ppm) in vegetative stage of potato could be increased the yield of potato.

Effect of sowing date and planting method on growth and yield of squash

The experiment was conducted at the research field of Agricultural Research Station, Rajbari, Dinajpur during *rabi* season of 2019-20 to find out the optimum sowing time and planting method of Squash and to increase the productivity and yield. Three different dates of sowing viz. November 1, November 10 and November 20 considered as factor A and planting method viz., Direct sowing and Transplanting considered as factor B. The experiment was laid out in randomized complete block (RCB) design (Factorial) with three replications.The unit plot size was 4m×4m. Early flowering (53.00 days) as well as early fruit harvesting (70 days) was occurred in November 1 sowing, where as sowing on November 20 resulted in delayed flowering (65.75 days) and fruit harvesting (90 days), respectively. Number of fruits per plant was also the highest (3.85) in November 1 sowing and the lowest (2.00) was in November 20 sowing. Seed sowing of November 1 was found better in respect of yield (35.25 t/ha) compared to November 10 (32.49 t/ha) and November 20 (21.73 t/ha) sowing. Between, the planting method direct sowing seed produced the highest (33.07 tha^{-1}) marketable yield while transplanting gave the lowest (26.57 t/ha) marketable yield.

Effect of sowing time and integrated nutrient management on growth, yield and quality of squash

The experiment was conducted at the research field of Agricultural Research Station, Rajbari, Dinajpur during rabi season of 2018-19 and 2019-20 to develop a profitable and economic fertilizer dose for squash and to increase the productivity and yield. Six different treatments were employed in this study viz., T_1= Vermicompost + 15 Nov. sowing, T_2= Cowdung + 15 Nov. sowing, T_3 = Poultry manure (PM) + 15 Nov. sowing, T_4 = Vermicompost + 30 Nov. sowing, T_5 = Cowdung + 30 Nov. sowing, T_6 = Poultry manure + 30 Nov. sowing. The highest fruit yield was recorded in T_1= Vermicompost + 15 Nov. sowing followed by that in T_2= Cowdung + 15 Nov. sowing and the lowest in T_6 = Poultry manure + 30 Nov. sowing.The unit plot size was 5.0m×4.0m.All organic manure was applied at the time of final land preparation. All recommended doses of phosphorus, sulphur, zinc and boron were applied in pit before one week of transplanting seedlings. Nitrogen and potassium were applied in three equal splits at 15, 30, and 45 DAT as ring method around the plants and mixed thoroughly with the soil.The highest gross return (Tk. 285440 ha^{-1}) as well as gross margin (Tk. 192850 ha^{-1}) was obtained in T_1= Vermicompost + 15 Nov sowing and the lowest gross return (Tk. 240720 ha^{-1}) and gross margin (Tk. 139120 ha^{-1}) were obtained from the treatment T_6 = Poultry manure + 30 Nov. sowing. The highest BCR was also obtained from the treatment T_1= Vermicompost + 15 Nov. sowing. The overall results indicated that among the treatments T_1= Vermicompost + 15 Nov. sowing and T_2= Cowdung + 15 Nov. sowing were found suitable for total productivity and economic return of the system.

Effect of integrated weed management on barley and soil microbes

The field experiment was conducted at the Agronomy Research Field of Bangladesh Agricultural Research Institute (BARI) during rabi season of 2019-2020 to find out suitable weed management practices in barley field and to observe the effect of herbicide on soil microbes. Treatments consist of T_1= Herbicide G-Penda 33 EC (Pendimethylene) @ 3 L/ha spraying at 4 days after sowing (DAS), T_2= Herbicide G-Penda 33 EC (Pendimethylene) @ 3 L/ha spraying at 4 DAS + one hand weeding (uprooting) at 25 DAS, T_3= One hand weeding at 25 DAS, T_4=Weeding by BARI weeder at 25 DAS and T_5= No weeding.The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 5 m× 4.4 m. Fertilizers at the rate of 85-25-45 kg/ha of N P K was applied in the form of urea, triple super phosphate and murate of potash, respectively. Half of N and all other fertilizer were applied as basal during final land preparation and rest N was applied at 25 and 50 DAS in equal split.Results showed that Shyama (Echinochola crusgali) was observed as a major weed in barley field. Number of weed/m^2 and weed control efficiency (WCE) was affected by different treatment. Yield components and yield of barley also significantly influenced by different treatment. The highest weed populations (118/m^2 and 56/m^2) were recorded in control plot at 25 and 50 DAS, respectively. The lowest (20 and 6 weed/m^2) were recorded in T_2 at 25 and 50 DAS. The highest WCE (weed control efficiency) was 83.05 and 96.65% at 25 DAE and 50 DAE respectively in T_2 treatment. The highest plant height of barley (97.07 cm) was obtained from control plot. The highest number of spikes /m^2 (418.33), spike length (11.17 cm), number of spikelet/spike (48.67), 1000-grain weight (38.87 g) and grain yield (3.94 t/ha) of barley were obtained from T_2 treatment. The highest gross return of Tk.79400/ha and BCR of 1.84 also obtained from the same treatment. The result revealed that application of herbicide G-Penda 33 EC (Pendimethylene) @ 3 L/ha spraying at 4DAS + one hand weeding (uprooting) at 25

DAS would be effective to control weeds for obtaining higher yield of barley.

Response of fertilizer and weed management on black cumin

The experiment was conducted at Agronomy Research Field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2018-2019 and 2019-20 to find out the optimum fertilizer dose and appropriate weed management method for getting higher yield and economic return of black cumin. The treatments were T_1= STB (Soil test basis fertilizer dose, FRG, 2018) 60-24-49-13-0-1 kg /ha N-P-K-S-Zn- B and two hand weeding at 30 DAE and 50 DAE of black cumin, T_2= STB +25% N-P-K and two hand weeding at 30 DAE and 50 DAE of black cumin, T_3= STB +50% N-P-K and two hand weeding at 30 DAE and 50 DAE of black cumin, T_4= STB and two hand spading at 30 DAE and 50 DAE of black cumin, T_5= STB +25% N-P-K and two hand spading at 30 DAE and 50 DAE of black cumin ,T_6= STB + 50% N- P- K and two hand spading at 30 DAE and 50 DAE of black cumin and T_7 = Native nutrient and no weeding (Control). The highest weed control efficiency % (WCE) 83.68 and 85.23% at 30 days after emergence (DAE) of black cumin and 93.62 % and 92.57 % at 50 days after emergence (DAE) of black cumin was found in T_3 (Two hand weeding at 30 DAE and 50 DAE of black cumin with STB + 50% NPK fertilizer dose) treatment in 2018-2019 and 2019-2020, respectively followed by T_2 (82.35 to 82.74% and 92.24 to 91.24%) treatment at 30 and 50 days after emergence (DAE) of black cumin in 2018-19 and 2019-20 respectively. Results showed that treatment T_3 (90-36-73-13-0-1 kg/ha of N-P-K-S-Zn-B (STB+50% N-P-K and two hand weeding at 30 and 50 days after emergence (DAE) of black cumin produced the higher seed yield 953.75 kg/ ha but higher benefit cost ratio 2.69 was obtained from T_4 treatment (soil test basis fertilizer dose: 60-24-49-13-0-1 kg/ha N-P-K-S-Zn-B) and two hand spading at 30 and 50 days after emergence of black cumin due to lower cost of production.

Carbon sequestration through residue management and crop productivity in potato-maize-T.aman cropping pattern in long term basis

The experiment was conducted at Agronomy Research Field in 2018-2019. Treatment were viz. T_1=Full residue of potato, maize and 1/3 of rice + 100% recommended fertilizer dose (RFD) of T.aman, T_2=Full residue of potato, maize and 1/3 of rice + 80% RFD of T.*aman*, T_3=Full residue of potato, maize and 1/3 of rice + 60% RFD of T.*aman*, T_4=Residue removed + 100% RFD of T.*aman*, T_5=Control (Farmers' practice). The experiment was laid out in a RCB design with three replications. Potato (var. BARI Alu -8) was sown on 20 November 2018 and harvested on 12 February 2019. Maize (var. BARI Hybrid Maize-9) was sown on 12 March 2019 and harvested on 17 June 2019. T. *aman* (var. BRRI dhan62) was transplanted on 18 July 2018 and harvested on 20 October 2019. Nutrients were applied as per treatments of recommended doses. Potato tuber yield was higher in all treatments (22.50-23.89t/ha) except T_5 (14.03 t/ha). Grain yield of maize was the highest in T_2 and T_3 treatments (4.77-4.91 t/ha). The highest grain yield of rice was obtained from T_1-T_4(4.08-4.34t/ha but the lowest in T_5 (3.17t/ha). Total organic C input from Potato-Maize–T. *aman* rice cropping pattern was noticed higher value in T_3 (11.15t/ha) and T_2 (10.58 t/ha) but the lowest in T_5 (6.69 t/ha). The highest total organic C adding from the pattern was estimated from T_3 (3.95 t/ha) and T_1 (3.82 t/ha) but the lowest in control T_5 (0.53 t/ha). Treatments, T_1, T_2 and T_3 showed positive balance of organic C in soil while T_3 showed the highest value (0.36%). The C sequestration was estimated the highest in T_3 (8.10 t/ha) while T_4 and T_5 sh*o*wed negative values. The results expressed that addition of plant residues as well as organic C in soil enhanced C balance or C sequestration in soil. Treatments, T_1, T_2 and T_3 showed positive balance of total C in soil while T_3 showed the highest value (0.036%). Negative balance of total C in soil was noticed in T_4 and T_5. Addition of crop residues enhanced slightly positive balance of total N in soil.

Performance of intercropping gardenpea with sorghum

The field experiment was conducted at Agronomy Research Field, Joydebpur and RARS, Burirhat, Rangpur, Bangladesh Agricultural Research Institute during rabi season of 2019-2020 to find out suitable combination of sorghum and gardenpea intercropping for higher productivity and monetary advantage. Treatments included in the experiment were: T_1= Sorghum normal row (SNR) +1 row gardenpea (GP),T_2=SNR +2 row GP,T_3= Sorghum paired row (SPR) +2 row GP, T_4=SPR + 3 row GP, T_5=SPR + 4 row GP, T_6=Sole sorghum (60 cm × 20 cm) and T_7=Sole GP (30 cm × 15 cm).The experiment was laid out in a randomized complete block design with three replications and the unit plot size was 4.8m × 5m. Variety BARI Sorghum-1 and BARI Motorshuti-3 were used in the experiment for both locations. Seeds of sorghum and gardenpea were sown on same day. Seeds were sown on 24 November 2019 at Joydebpur and 15 November 2019 at Burirhat. Seeds of both crops were treated with provax @ 3g/ kg of seed in both locations. Fertilizers were applied at the rate of 120-48-75-30-3-1kg/ha of N, P, K, S, Zn, B 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 25 and 45 days after sowing (DAS) of sorghum. In intercrop, extra N (40 kg/ ha) was applied in 2 splits at 25 and 45 DAS to gardenpea. Sole gardenpea was fertilized at the rate of 46- 25-31-13-2.1 kg/ ha of N, P, K, S and Zn. One third of N and all other fertilizers were applied as basal. Rest N was applied in 2 splits at 20 and 35 DAS in both locations. Light availability on gardenpea decreased with the increase of shade produced by sorghum canopy over the time up to 60 DAS. The lowest light availability on gardenpea was observed in T_2 treatment and the highest light availability was observed in sole gardenpea (T_7) followed by T_3 treatment. The maximum grain yield of sorghum was observed in sole crop and it was decreased by 1-12 % at Joydebpur and 7-17 % at Burirhat. The highest sorghum equivalent yield (SEY) (12.02t/ha at Joydebpur and 11.07 t/ha at Burirhat) and the highest land equivalent ratio (LER) (1.93 at Joydebpur and 1.80 at Burirhat) were observed in T_5 treatment. The highest gross margin (Tk.73200/ha at Joydebpur and Tk 65700/ha at Burirhat) and benefit cost ratio 2.56 and 2.46 at Joydebpur and Burirhat, respectively, were also found in the same treatment. The results revealed that sorghum paired row + 4 row gardenpea might be agronomically feasible and economically profitable for sorghum + gardenpea intercropping system at Joydebpur and Burirhat region.

Performance of intercropping dwarf yard long bean with maize under different planting system

The field experiment was conducted at Agronomy Research Field, Joydebpur and RARS, Bangladesh Agricultural Research Institute during *kharif* season of 2020 to find out suitable combination of maize and dwarf yard long bean intercropping for higher productivity and monetary advantage. Treatments included in the experiment were: T_1= Maize normal row (MNR) +1 row dwarf yard long bean (DYLB), T_2= Maize paired row (MPR) + 2 row DYLB, T_3= MPR +3 row DYLB, T_4= MPR +4 row DYLB, T_5= Sole maize (60 cm × 20 cm) and T_6=Sole DYLB (30 cm × 20 cm).The experiment was laid out in a randomized complete block design with three replications and the unit plot size was 4.8 m × 5 m. Hybrid maize (var. BARI Hybrid maize-9) and DYLB (Local) were used. Seeds of both crops were sown on 15 March, 2020. The seeds of both crops were treated with provex@ 3 g/ kg seed. Fertilizers were applied at the rate of 225-60-120-45-4-1.6 kg/ ha of N, P, K, S, Zn, B 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 at 20 DAS as side dress to DYLB. Sole DYLB was fertilized at the rate of 21- 27-33-9-1.2-1.2 kg/ ha of N, P, K, S, Zn and B. Two third of N and all other fertilizers were applied as basal. Rest N was applied at 20 and 40 DAS.Light availability on DYLBdecreased with the increased of shade produced by maize canopy over the time up to 100 DAS. The lowest light availability on DYLB was observed in T_1 treatment and the highest light availability was observed in sole DYLB(T_6) followed by T_2 treatment. The maximum grain yield of maize was observed in sole maize and it was decreased by 1.0-7.5 % among the intercrop treatments. The highest maize equivalent yield (MEY) (10.74) t/ha, gross margin (Tk. 95380/ha) and benefit cost ratio (1.97) were observed inT_2.

The highest land equivalent ratio LER of 1.31 was also found in the same treatment. The results revealed that maize paired row + 2 row dwarf yard long bean might be agronomically feasible and economically profitable for maize + dwarf yard long bean intercropping system at Joydebpur region.

Maize- legume strip cropping for resource conservation

A field experiment was conducted under irrigated condition during *rabi* season, 2019 at the Agronomy research field of Bangladesh Agricultural Research Institute. The experiment consisted of five different treatments viz., T_1= Maize (4 row) alternate with lentil (8 row). T_2= Maize (4 row) alternate with Pea (8 row). T_3= Maize (4 row) alternate with grass pea (6 row). T_4= Sole Maize (8 row). Experiment was laid out in a Randomized Complete Block Design with three replications and each plot of 4.8 x 3.0 m^2. Maize variety BARI Hybrid maize-9, Lentil Variety BARI Masur-9, pea variety BARI Motorsuti-3 and grasspea variety BARI Khasari-1were used as test crop. All crops were sown on 26 November 2019. Five tones of Cowdung per ha was applied to the crop field before sowing. Recommended dose of fertilizer was applied to all crops (for maize: 225-60-120-45-4-1.6 kg/ha N P K S Zn B; for lentil: 21-18-21-9-2-1.2 kg/ha N P K S Zn B; for pea 45-24-30-12-1.4 kg/ha N P K S Zn and for grasspea 15-15-18-9 kg/ha N P K S). For maize one third of N and all of other fertilizer were applied during final land preparation and rest N was applied in two equal splits at 30-35 days after sowing and 50-60 days after sowing. For other three crops all fertilizer would be applied during final land preparation.The maximum grain yield of maize was observed in sole crop. The highest maize equivalent yield (14.21 t/ha), gross margin (Tk. 213150/ha) and benefit cost ratio (3.04) were observed in T_2. The result revealed that farmers could be benefited by cultivating any one maize legume stripcropping. But among the three systems, maize pea strip cropping is the best.

Performance of legume vegetables intercropping with chilli

The field experiment was carried out on chilli legume vagetables intercropping systems using five treatments at the Agronomy Research Field of Bangladesh Agricultural Research Institute (BARI) and RARS Hathazari, Chattagram during *rabi* season, 2019-20. The study was conducted to find out the suitable intercrop combination of maize legume vegetable. The treatments were; T_1= Sole Chilli (60 cm × 50 cm), T_2= Chilli (100%) + one row bush bean (50%), T_3= Chilli (100%) + two row bush bean (100%), T_4= Chilli (100%) + one row pea (50%), T_5= Chilli (100%) + two row pea (100%).Experiment was laid out in a Randomized Complete Block Design with three replications and each plot of 3.6 x 3.0 m^2. Chilli (cv. BARI Morich-3) was transplanted with 2 seedling per hill and later maintained one seedling per hill. The inter row spacing was 60 cm and intra row spacing was 50 cm. Intercrops were sown between the rows. Bushbean**:** BARI Jharsheem-2, Pea**:** BARI Motorsuti-3 were use as test crop. Five tones of Cowdung per ha was applied to the crop before transplanting. Basal dose of fertilizer was applied to chilli @ 96-45-75-15-1.5-1.4 kg/ha N P K S Zn B. Half of N and all other fertilizers will be applied as basal during final land preparation. Remaining N was applied in three equal splits at 25, 50 and 70 DAT. Significantly the highest yields (8.53 tha^{-1} at Joydebpur and 10.62 t/ha at Hathazari) were obtained in sole chilli. Yield of chilli varied with different intercropping systems. Chilli +one inter row pea intercropping system results in significantly the highest yield (8.17 t/ha at Joydebpur and 10.31 t/ha at Hathazari) in chilli. On the contrary 'chilli + two inter row bushbean' resulted in lower yield of chilli (6.50 t/ha at Joydebpur and 7.71 t/ha at Hathazari) should be included chilli equivalent yield. The highest net returns (Tk. 184096/ha at Joydebpur and 257750/ha at Hathazari) and BCR (4.09 at Joydebpur and 2.36 at Hathazari) were obtained in chilli + one row pea intercropping. This obviously reflected the importance of intercropping to increase the productivity per unit area. Further, it also offers insurance against crop failure.

Intercropping spinach and red amaranth with brinjal under different planting system

The experiment was conducted at Agronomy Research Field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during *rabi* season of 2018 to 2019 and 2019 to 2020 to find out the suitable crop combination of spinach and red amaranth with brinjal for increasing total productivity, economic return and maximize land utilization through intercropping system. Seven treatments viz., T_1 = 2 row Spinach (50%) in between two row of brinjal (100%), T_2 = 3 row Spinach (75%) in between two row of brinjal (100%), T_3 = 2 row red amaranth (50%) in between two row of brinjal (100%), T_4 = 3 row red amaranth (75%) in between two row of brinjal (100%),T_5 = Sole brinjal (80 cm × 60 cm), T_6 = Sole spinach (Line to line 20 cm) and T_7 = Sole red amaranth (Line to line 20 cm) were used in the study. The trial was set up in a randomized complete block design with three replications. The unit plot size was 4.2 m × 3.2 m. The sole crop of brinjal and intercropped treatments were fertilized with cow dung @ 5 t/ha and 120-31-120-13-3-1.5 kg/ha of N-P-K-S-Zn-B in the form of urea, triple super phosphate, murate of potash, gypsum, zinc sulphate and boric acid, respectively. For sole brinjal and intercrop full amount of all other fertilizer except N and K were applied in pit before 1 week of transplanting brinjal. N and K were applied in three equal splits at 21, 40 and 60 days after transplanting (DAT) of brinjal as ring method followed by irrigation. Sole spinach fertilized with 50-13-18-5 kg/ha of N-P-K-S. Half N and all other fertilizers were applied at the time of final land preparation and rest N was applied at 10 days after emergence (DAE) of spinach. Sole red amaranth fertilized with 78- 18- 35- 4 kg/ha of N-P-K-S. Half N and all other fertilizers were applied at the time of final land preparation and rest N was applied at 10 DAE of red amaranth (FRG, 2018). Brinjal (var. BARI Begun-8) as main crop and red amaranth (var. BARI Lalshak-1) and spinach (var. BARI Spinach-1) were used as intercrops in this study. The sole crop of brinjal was planted at a spacing of 80 cm × 60 cm. After establishment of brinjal seedling (12 days after transplanting) spinach and red amaranth seeds were sown as per treatments. Brinjal (Thirty days old seedling) was transplanted on 29 November, 2018 and 10 Decmber 2019. Seed of spinach and red amaranth were sown on 11 December, 2018 and 23 December, 2019. Brinjal was harvested four times and it was harvested in 2019 on 04 March, 11 March, 18 March, 29 March and in 2020 harvested on 03 April, 13 April, 21 April, and 2 May. Both spinach and red amaranth were harvested on 13 January, 2019 and 27 Janury, 2020. Results showed that all the intercropping combinations showed better performance in terms of brinjal equivalent yield, gross return and benefit cost ratio (BCR) over sole crops. Among the intercropping combinations, 3 row spinach (75%) in between two row of brinjal (100%) was the most feasible and profitable intercropping system in respect of brinjal equivalent yield (36.32 t/ha and 34.39 t/ha), land equivalent ratio (1.67 and 1.52), gross return (Tk. 7,26,300/ha and Tk. 6,87,746/ha), gross margin (Tk. 4,91,042/ha and Tk. 4,52,488/ha) and BCR (3.09 and 2.92) during 2018-19 and 2019-2020, respectively.

Intercropping onion and garlic with brinjal under different planting system

The experiment was conducted at the Agronomy Research Field of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during *rabi* season of 2019 to 2020 to find out the suitable crop combination of onion and garlic with brinjal for increasing total productivity, economic return and maximize land utilization through intercropping system. Seven treatments viz., T_1= Brinjal (80 cm × 60 cm) 100% + 4 row onion (15 cm × 10 cm) 57%, T_2= Brinjal (80 cm × 60 cm) 100% + 3 row onion (15 cm × 10 cm) 43%, T_3= Brinjal (80 cm × 60 cm) 100% + 4 row garlic (15 cm × 10 cm) 57%, T_4= Brinjal (80 cm × 60 cm) 100% + 3 row garlic (15 cm × 10 cm) 43%, T_5= Sole brinjal (80 cm × 60 cm) 100%, T_6= Sole onion (15 cm × 10 cm) 100%, T_7= Sole garlic (15 cm × 10 cm) 100% were used in the study. The trial was set up in randomized complete block design with three replications. The unit plot size was 3.2 m × 4.2m. The sole crop of brinjal and intercropped treatments were fertilized with cowdung 5 t/ha and 140- 41-120-18- 3- 1.5 kg/ha N-P-K-S-Zn-B in the form of urea, triple super phosphate, murate of potash, gypsum, zinc sulphate and boric acid, respectively. For sole brianjal and intercrop, except N and K, full amount of all other fertilizer were applied in pit before 1 week of transplanting. N and K were applied in three equal splits at 21, 40 and 60 days after transplanting (DAT) brinjal as ring method followed by irrigation. Sole onion and garlic were fertilized with105- 60- 144- 32- 3.5- 2.1 kg/ha N-P-

K-S-Zn-B and 135- 57- 105- 50- 4.0- 4 kg/ha N-P-K-S-Zn-B in the form of urea, triple super phosphate, murate of potash, gypsum, zinc sulphate and boric acid, respectively. For onion and garlic half N, K and all other fertilizers were applied at the time of final land preparation. Rest N and K were applied in two equal splits at 25 DAT and 50 DAT under moist soil condition and mixed thoroughly with the soil as soon as possible for better utilization (FRG, 2018). Brinjal (var. BARI Begun-8) as base crop and onion (var. BARI Piaz-4) and garlic (var. Faridpur local) were used as intercrops in this study. The sole crop of brinjal was planted at a spacing of 80 cm × 60 cm. In intercropping system four rows of onion (57%), three rows of onion (43%), four rows of garlic (57%) and three rows of garlic (43%) were intercropped in between two rows of brinjal. After establishment of brinjal seedling (10 days after transplanting) onion seedling and garlic cloves were sown as per treatments. Brinjal thirty days old seedling, onion seedling and cloves of garlic were transplanted/sown on 10 December, 2019 and 20 December, 2019, respectively. Brinjal was harvested four times (12 March, 23 March, 18 April and 7 May, 2020). Onion and garlic were harvested on 28 March, 2020. Results showed that all the intercropping combinations showed better performance in terms of brinjal equivalent yield, gross return, gross margin and benefit cost ratio over sole crops. Among the intercropping combination, 4 row garlic (15 cm × 10 cm) 57% in between two row of brinjal (80 cm× 60 cm) 100% was the most feasible and profitable intercropping system in respect of brinjal equivalent yield (37.99 t/ha), land equivalent ratio (LER)1.31, gross return (Tk. 7,59,800/ha), gross margin (Tk. 5,34,063/ha) and benefit cost ratio (3.37).

Long term effect of four crop based cropping pattern on soil health and crop productivity

The experiment was conducted at the Research Field of Agronomy Division BARI, Joydebpur, Gazipur (AEZ 28), during of 2017-18 and 2018-19 to increase cropping intensity and productivity in rice based cropping pattern along with observing soil health. Four treatments of cropping sequence were: CP_1 = Mustard--Mungbean–T. *Aus* – T.*aman*; CP_2 = Potato –Mungbean–T. *Aus* – T.*aman*; CP_3 = Garden pea –Mungbean–T. *Aus* – T.*aman*; CP_4 = Potato –Red amaranth–Maize – T.*aman*.The experiment was laid out in a RCB design with 3 replications. The unit plot size was 4.8 m × 4.2 m. Potato tubers (var. BARI Alu-7) were planted in *rabi* season with 60 cm × 25 cm spacing with 330 – 200 – 280 – 100 – 8 – 6 kg/ha of urea-TSP-MoP-gypsum-zinc sulphate-boric acid respectively. Mustard (var. BARI Sarisha-14) was grown during *rabi* season. Mustard was sown with 30 cm × 5 cm spacing and fertilizers (@ 280 – 170 – 90 – 160 – 6 – 10 kg/ha of urea-TSP-MoP-gypsum-zincsulphate-boric acid, respectively. Garden pea (var. BARI Motorshuti-3) was grown during *rabi* season with 30 cm × 5 cm spacing and fertilizers (@ 30 – 80 – 40 – 50 – 7 kg/ha of urea-TSP- MoP- gypsum - boric acid, respectively. Red amaranth (var. BARI lalshak-1) was broadcasted during early *Kharif-I* season.Mungbean was grown during *Kharif-I* season with Urea-TSP- MP @ 40-80-35-115 kg/ha andwere sown in continuous line with 30 cm row to row spacing.Maize (var. BARI Hybrid maize- 9) was sown during *Kharif- I* season and Urea-TSP- MoP-Gypsum-Boron @ 250-130-90-125-8 kg/ha, respectively. Transplanted *aus* (cv. Parija) rice was transplanted (twenty five days aged seedling) with 15cm × 15 cm spacing and urea-TSP-MoP @ 135-55-85 kg/ha, respectively. Transplanted *aman* (var. BRRI dhan 62) rice (twenty five days aged seedling) was transplanted during Kharif II season with TSP, MoP and gypsum @ 150-55-85-60 kg/ha, respectively.The results showed that four crops could be grown successfully one after another in a sequence in all the cropping patterns. The highest Rice Equivalent Yield (REY) was recorded from the cropping sequence CP_4 (37.99 t/ ha in 2017-18 and 38.74 t/ ha in 2018-19).The highest gross margin was obtained from CP_4 (Tk. 483773 in 2017-18 and 497273/ha in 2018-19). The highest benefit cost ratio (BCR) was found in CP_4 (3.42 and 3.49) and it might be due to higher return and lower cost of production followed by CP_3 (3.17 and 2.96). Nitrogen level was found increased in all the patterns and it might be due to incorporation of plant residues after each cropping and left over nitrogen after plant uptake. Amount of potassium were increased in CP_1, CP_3 and CP_4 but decreased in CP_2. In all the patterns, sulfur, boron, zinc levels were decreased. CP_4 (Potato- Red amaranth-Maize- T. aman) was the highest scorer (7.4) and was the most suitable pattern for sustainable crop production along with maintaining soil health.

Long term effect of four crop based cropping pattern on productivity and soil health

The field experiment was conducted at the research farm of Regional Agricultural Research Station, Burirhat, Bangladesh Agricultural Research Institute during 2017-18 and 2018-19 to find out the crop productivity trends in long term basis and to determine soil nutrient balance in long term basis find out the soil condition for long term effect. The treatments were: C_1: Mustard-Mungbean-T. *Aus* rice- T. *Aman* rice (CP_1), C_2: Potato-Mungbean-T. *Aus* rice- T. *Aman* rice (CP_2), C_3: Wheat-Mungbean- T. *Aus* rice -T. *Aman* rice (CP_3), T_4: Potato- Wheat-Mungbean-T. *Aus* rice -T. *Aman* rice (CP_4) and T_5: Potato-Maize-T. *Aman* rice, (CP_5): (FP). The unit plot size was 4.0 m. × 5 m. The design was factorial RCB with three replications. The fertilizer dose was followed by Fertilizer Recommended Guide, 2012.Results showed that total equivalent tuber yield C_1 to C_5 cropping pattern were more or less same.This result was recorded 2017-18 year after one cycle completed and also soil status showed compare initial year (2016-17) with 2017-18. There was no significant difference of soil status after one year on the effect of four crop base cropping pattern.

Long term effect of four crop-based cropping pattern on crop productivity and soil health

An Experiment was conducted at the Regional Agricultural Research Station, Jamalpur (AEZ 8) during rabi 2018-2019 (November 2018 through November 2019) to increase cropping intensity and productivity in rice based cropping system for sustaining food security, poverty reduction, resource management and livelihood improvement of ever increasing populations. Four treatments of cropping pattern were as follows: CP_1 = Mustard – Mungbean –T. *aus* – T. *aman*, CP_2 = Potato – Mungbean –T. *aus* – T. *aman*, CP_3 = Garden pea – Mungbean –T. *aus* – T. *aman* and CP_4 = Potato – Black gram –T. *aman*. The highest REY (27.94 t/ha) was recorded from the cropping pattern Potato – Mungbean –T. *aus* – T. *aman* followed by Potato – Black gram –T.aman (24.54 t/ha). The lowest REY (9.62t/ha) was obtained from the cropping pattern Mustard – Mungbean –T. *aus* – T. *aman*.

Estimation of nutrition from different cropping pattern

The experiment was conducted at the Research Field of Agronomy Division BARI, Joydebpur, Gazipur (AEZ 28), during 2018-19 to increase cropping intensity and productivity in rice based cropping pattern along with maintaining nutritional security. Four treatments of cropping sequence were: CP_1 = Lentil-Maize – T. *aman*; CP_2 = Lentil- Red amaranth –Mungbean– T. *aman*; CP_3 = Wheat – Red amaranth –Mungbean– T. *aman*; CP_4 = Wheat-Mungbean– T. *aman*. The experiment was laid out in a RCB design with 3 replications. The unit plot size was 4.8 m × 4.2 m.Lentil (var. BARI lentil-6) was grown during *rabi* season with Urea-TSP- MoP-Gypsum-Boron @ 40-80-35-50-8 kg/ha, respectively and was sown in continnous line with 30 cm row to row spacing.Wheat (var. BARI Gom-30) was grown during *rabi* season with Urea-TSP- MoP-Gypsum-Boron @ 160-140-100-115-6 kg/ha, respectively, at continnous line with 30 cm row to row distance. Red amaranth (var. BARI lalshak-1) was broadcasted during early *Kharif-I* season. Mungbean was grown during *Kharif-I* season and Urea-TSP- MP @ 40-80-35-115 kg/ha andwere sown in continuous line with 30 cm row to row spacing. Maize (var. BARI Hybrid maize- 9) was sown during *Kharif-I* season and Urea-TSP- MoP-Gypsum-Boron @ 250-130-90-125-8 kg/ha, respectively. Transplanted *aman* (var. BRRI dhan 62) rice (twenty five days aged seedling) was transplanted during *Kharif-II* season with TSP, MoP and gypsum @ 150-55-85-60 kg/ha, respectively. The higher rice equivalent yield was recorded from CP_2 (29.44 t/ ha). The highest gross return (Tk. 529920/ha) gross margin (Tk. 446680/ha), benefit cost ratio were obtained an CP_2 (6.37). Carbohydrate was prominent in CP_1 (8668.96 kg/ha). The highest amount of protein was found in CP_1 (1468.80 kg/ha) and the lowest was found in CP_4 (686.25 kg/ha). The fatty acid content was highest in CP_1 (4312.24 kg/ha) and lowest in CP_3 (3666.01 kg/ha). Iron and Vitamin B-6 content were found the highest in CP_2 (810.80 and 23493.99 g/ha, respectively) and the lowest were found in CP_4 (428.51 and 12.01 g/ha, respectively). The highest amount of zinc was obtained from CP_3 (343.53 g/ha) and the lowest was found in CP_4. CP_1 was found rich in vitamin A (1073.83 mg/ha) as other patterns were very much poor compared to CP_1. The highest amount of calorie was obtained from CP_1 (5.78×10^7calorie/ha). The highest amount of calorie gained per taka cost was found in CP_1 (555.13 calorie/taka).Although CP_2 produce the height BCR, CP_1 is the best in terms of cost per calorie in total calorie content. CP_1 showed the highest pattern score (8). So CP_1 (Lentil - Maize – T. *aman*) might be recommended for nutritional security of Bangladesh with economic subsistence.

Performance of relay bitter gourdinchilli+red amaranth intercropping without trailis at medium high land under AEZ-9

An experiment was carried out to find suitable relay bitter gourd with chilli+lalsak intercropping at Regional Agricultural Research Station, Jamalpur during November 2019 to August 2020.The experiment consisted of five treatments viz., T_1= Sole chilli (60cm×60cm), T_2= Chilli (100%) +3 row red amaranth + relay bitter gourd (60cm×150cm), T_3= Chilli (100%)+ 3 row red amaranth + relay bitter gourd (120cm×150cm), T_4= Chilli (100%)+ 3 row red amaranth + relay bitter gourd (180cm×150cm), T_5= Chill paired row+ 6 row red amaranth + relay bitter gourd (105m×150cm).The treatments were tested in randomized complete block design with 3 dispersed replications. The unit plot size was 3 m × 3.6 m and spacing for chilli was 60 cm × 60 cm. BARI Morich-2 for chilli, BARI Lalsak-1 for red amaranth and BARI korolla-1 for bitter gourd were used. Chilli was transplanted on 14 November 2019, red amaranth was sown on 21 November 2019 and bitter gourd was transplanted on 12 April 2020. Red amaranth was harvested 17 December 2019, chilli harvested started on 8 April 2020 and continued up to 26 July 2020 and bitter gourd harvested started on 31 May 2020 and continued up to 2 August 2020. Red amaranth and bitter gourd were sown in lines between the chilli rows maintaining the spacing of the respective treatments. Fertilizers applied were 128-76-128-20-21.5 kg/ha NPKSZnB with cowdung 5 t/ha for chilli and 100-40-60-20-1.5 kg/ha NPKSB and cowdung 5 t/ha for bitter gourd.The result indicated that chilli yield was reduced due to relay cropping systems. The highest chilli yield (16.52 t/ha) was found from sole chilli and lowest fruit yield (9.91 t/ha) was found from chilli (100%) +3 row red amaranth + relay bitter gourd (60cm×150cm). The highest chilli equivalent yield (33.02 t/ha) was obtained from chilli paired row + 6 row red amaranth + relay bitter gourd (105cm×150cm) and the lowest chilli equivalent yield (16.52 t/ha) was found from sole chilli treatment.

Performance of relay bitter gourd with chilli+onion intercropping without trailis at medium high land under AEZ-9

An experiment was carried out to find suitable relay bitter gourd with chilli+onion intercropping at Regional Agricultural Research Station, Jamalpur during November, 2019 to June, 2020. The experiment consisted of five treatments, viz., T_1= Sole chilli (60cm×60cm), T_2= Chilli (100%)+ 4 row onion+ relay bitter gourd (60cm×150cm), T_3= Chilli (100%)+ 4 row onion+ relay bitter gourd (120cm× 150cm), T_4= Chilli (100%)+ 4 row onion + relay bitter gourd (180cm×150cm), T_5= Chillipaired row+ 8 row onion+ relay bitter gourd (105cm×150cm).The treatments were tested in randomized complete block design with 3 dispersed replications. The unit plot size was 3 m × 3.6 m and spacing for chilliwas 60 cm × 60 cm. BARI Morich-2 for chilli, BARI Piaj-4 for onion and BARI korolla-1 for bitter gourd were used. Chilli was transplanted on 19 November 2019, onion was transplanted on 24 November 2019 and korolla was transplanted on 12 April 2020. Onion was harvested on 05 March 2020, chilli harvested started on 10 April 2020 and continued up to 26 July 2020 and bitter gourd harvested from 1 June 2020 and continued up to 3 August 2020. Onion and bitter gourd were sown in lines between the chilli rows maintaining the spacing of the respective treatments. Fertilizers were applied 128-76-128-20-21.5 kg/ha NPKSZnB with cowdung 5 t/ha for chilli and 100-40-60-20-1.5 kg/ha NPKSB and cowdung 5 t/ha for bitter gourd. The result indicated that chilli yield was reduced due to relay cropping systems. The highest chilli yield (13.94 t/ha) was found from sole chilli treatment and lowest yield (8.09 t/ha) was found from chilli (100%)+ 4 row onion+ relay bitter gourd (60cm×150cm) treatment. The highest chilli equivalent yield (53.70 t/ha) was obtained from chilli paired row + 8 row onion + relay bitter gourd (105cm×150cm) and the lowest was sole chilli treatment.

Performances of selected minor cereals as relay crops with T.*aman* rice in southern region of Bangladesh

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during Rabi season of 2019-2020 to evaluate the performances of selected minor cereals as relay crops with T.aman rice towards increasing the cropping intensity in the southern region of Bangladesh. The treatment of the experiment was four minor cereal crops viz., T_1 = Barley (Hordeum vulgare), T_2 = Kaon (Setaria italica), T_3 = Cheena (Panicum miliaceum), and T_4 = Sorghum (Sorghum bicolor). The experiment was laid out in randomized complete block design with three replications.The unit plot size was 5 m × 4 m. The seeds of the minor cereals were sown on 26 November, 2019 as relay crops with previous T.*aman* rice (var. BRRI dhan 11). The varieties of these crops were BARI Barley-9 (Barley), BARI Kaon-3 (Kaon), Tusar (Cheena) and BARI Sorghum-1 (Sorghum). Seeds of these minor crops were sown through broadcasting method at the seed rate of barley 120 kg/ha, kaon 10 kg/ha, cheena 20 kg/ha, and sorghum 10 kg/ha. Fertilizer nutrients were applied in the plots of the minor cereal crops as per their respective recommended doses and methods (FRG, 2018). The seed yields were found 1780 kg/ha in barley, 1675 kg/ha in kaon, 1125 kg/ha in cheena and 5070 kg/ha in sorghum. The experimental results further revealed that all the tested minor cereal crops (barley, kaon, cheena and sorghum) as relayed with T.aman rice performed well. However, from economic point of view sorghum and barley cultivation was more profitable as compared to kaon and cheena.

Intercropping of cauliflower with sweet gourd at different plant population

The suitability study of cauliflower with sweet gourd were studied by conducting a field experiment to find out the suitable cauliflower combination which perform better intercropped with sweet gourd at RARS, Hathazari, Chattogram and Rajbari, Dinajpur during 2019-20. There were seven treatments T_1=Sole Sweet gourd (2m × 2m), T_2=100% Sweet gourd + 3 rows cauliflower (60cm× 50cm), T_3=100% Sweet gourd + 3 rows cauliflower (60cm × 80cm), T_4=100% Sweet gourd + 4 rows cauliflower (50cm × 100cm), T_5=100% Sweet gourd + 4 rows cauliflower (50cm × 80cm), T_6=100% Sweet gourd + 5 rows cauliflower (40cm × 100cm) and T_7=Sole Cauliflower (50cm × 50cm). The experiment was laid out in randomized complete block design replicated 3 times. The unit plot size was 4m × 4m. Fertilizer was applied at the rate of 80-36-100-20-1.5-1 kg ha^{-1} N-P-K-S-Zn-B for sole cauliflower through urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. BARI Misti kumra-2, BARI Fulcopy-1 was used in this experiment. In sole sweet gourd and intercrop fertilizers were applied at the rate of 80-36-100-24-2-2 kg/ha of N-P-K-S-Zn-B through urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. The maximum SGEY was obtained from T_4 followed by that of T_2. The maximum gross return, gross margin and BCR were also obtained from T_4 which was followed by T_2 and the lowest in sole cauliflower (T_7). The overall results indicated that among the intercrop combinations, T_4=100% Sweet gourd + 4 rows cauliflower (50cm × 100cm) and T_3=100% Sweet gourd + 3 rows cauliflower (60cm × 80cm) combinations might be economically profitable for cauliflower with sweet gourd intercropping system.

Improvement of cropping intensity through realy yard long bean in maize+ bush bean (khaissa) intercropping

A field trail was conducted at RARS, BARI, Burirhat, Rangpur, to observe the performance of relay yard long bean in maize-bush bean intercropping and to increase the total productivity. during rabi season of 2018-19 and 2019-2020. There were four treatments viz. T_1= Maize paired row + 4 row French bean relayed with yard long bean, T_2= Maize single row + 2 row French bean relayed with yard long bean T_3= Maize single row with relay yard long bean and T_4= Sole maize (75 cm× 25 cm).The design was RCB with three replications. The size of the unit plot was 3 m. × 3 m. All Maize + French bean/yard long bean system gave higher maize equivalent yield (69.00-70.50t/ha). This system also gave better economic return in respect of gross margin (Tk. 751300-771800/ha) and BCR (3.64-3.70 in 2018-19). In 2019-20 only maize and bushbean harvested.

Development of vegetable based cropping pattern for increasing cropping intensity and ensuring nutrition

In the context of developing vegetable based cropping patterns and ensuring nutrition, a field experiment was conducted at the Regional Agricultural Research Station, Jashore, Bangladesh during 2018-19 and 2019-2020 consecutive years. The objectives of this study were i) to find out the suitable cropping pattern based on vegetable for higher productivity and nutrition and ii) to estimate economic return of vegetable based cropping patterns. The cropping patterns were as follows: CP_1= Transplanted Aman rice (Bina dhan 16) – Spinach (local) – Gardenpea (BARI Motorshuti-3) - Mungbean (BARI Mung-6) - Transplanted Aus rice (Bina dhan 19); CP_2= T. Aman rice – Cabbage (Atlas70)–Spinach – Yard long bean (Aduri)- T. *Aus* rice; CP_3= T. *Aman* rice – Cauliflower (Snowball)–Spinach – Yard long bean- T. Aus rice; CP_4= T. Aman rice –Coriander (BARI Dhonia-1) – Gardenpea – Mungbean - T. Aus rice; CP_5= T. *Aman* rice – Cauliflower –Spinach – Mungbean - T. *Aus* rice and CP_6 = T. *Aman* rice – Cauliflower–Mungbean - T. Aus rice (Farmer's practice).These cropping patterns (CP_1, CP_2, CP_3, CP_4, and CP_5) are composed with five crops; and last cropping pattern is used as farmer's practice (control) to compare with the other five cropping patterns.The experiment was laid out in a Randomized Complete Block (RCB) design with four replications. The unit plot size was 6 m × 4 m. Thirty days old seedlings of Transplanted aman (T. *aman*) rice BRRI dhan75 and BINA dhan-16 was transplanted on 12 August 2018 and 08 August 2019 during the Kharif-2 season, respectively and it was the first crop of the sequence. Fertilizers were applied @ 69: 12:35:6:3 kg/ha of N: P: K: S: Zn in the form of urea, TSP, MoP, gypsum and zinc sulphate, respectively. The entire amount of TSP, MoP, gypsum and zinc sulphate were applied as basal. Seedlings were grown in separate plot. The results showed that five crops may be grown successfully one after another in a sequence in all the nutrition enriched vegetable based cropping patterns. The average highest total rice equivalent yield (TREY) 35.3 tha^{-1} was recorded from the cropping pattern T. *Aman* rice – Cauliflower – Spinach – Yard long bean- T. *Aus* rice (CP3) which was followed by T. Aman rice –Cabbage–Spinach– Yard long bean- T. Aus rice(35.0 tha^{-1}) and T. *Aman* rice – Cauliflower –Spinach – Mungbean - T. Aus rice (32.9 tha^{-1}). The average lowest REY (21.0 tha^{-1}) was obtained from the cropping pattern T. *Aman* rice – Spinach – Gardenpea -Mungbean- T. *Aus* rice (CP_1). The average highest gross return (BDT 7,05,597 /ha) was recorded from T. *Aman* rice – Cauliflower –Spinach – Yard long bean- T. *Aus* rice (CP3) cropping pattern which was followed by T. *Aman* rice – Cabbage–Spinach – Yard long bean- T. *Aus* rice(BDT 6,99,288 /ha) and T. *Aman* rice – Cauliflower –Spinach – Mungbean - T. *Aus* rice (BDT 6,57,192 /ha). The average highest net income BDT 3,88, 051 /ha was obtained fromT. Aman rice – Cabbage–Spinach – Yard long bean- T. Aus rice which was followed by T. *Aman* rice – Cauliflower –Spinach –Yard long bean- T. *Aus* rice (BDT 3,84,360 /ha).The highest marginal benefit cost ratio (MBCR) 3.84 was obtained from the cropping pattern T. *Aman* rice – Cabbage–Spinach – Yard long bean- T. *Aus* rice which was followed by T. *Aman* rice – Cauliflower –Spinach – Yard long bean- T. Aus rice (2.96).In terms of rice equivalent yield, the highest total rice equivalent yield was increased 18%, 16.95% and 9.91% in T. *Aman* rice – Cauliflower –Spinach – Yard long bean- T. *Aus* rice, T. *Aman* rice – Cabbage–Spinach – Yard long bean- T. *Aus* rice and T. *Aman* rice – Cauliflower –Spinach – Mungbean- T. *Aus* rice cropping pattern compared to Farmers' practice (FP).

Development of fertilizer packages for five crop based cropping pattern in rice based cropping system

In the context of developing the fertilizer packages, a field experiment was conducted at the Regional Agricultural Research Station, Jashore, Bangladesh during 2015-16, 2016-17, 2017-18, 2018-19 and 2019-2020 consecutive years. 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% NPK, T_7= 75% of T_1 and T_8= Native fertility. The cropping pattern was 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. Fertilizer doses were applied as per treatment requirements in the form of Urea, TSP, MOP, Gypsum and Zinc sulphate, respectively. Rice equivalent yield was differed under different treatments. The highest total REY 21.60 t/ha was recorded from the Treatment T_6 which was followed by T_4 (19.87 tha^{-1}), T_3 (19.56 t/ha), T_5 (19.44 tha^{-1}) and T_2 (19.20 t/ha). The lowest total REY (10.21 t/ha) was obtained from the native nutrient treatment (T_8). The highest gross margin (BDT 53510 ha^{-1}) was recorded from the treatment T_6 which was followed by T_4 (BDT 21260 /ha) and T_3 (BDT 13740 /ha), respectively. The highest marginal benefit cost ratio (MBCR) 9.4 was obtained from the treatment T_6which was followed by the treatment T_4 (6.3) and T_5 (4.7). Total REY wasincreased by (T_6) 16.10 %, (T_4) 6.79 %, (T_3) 5.13 % and (T_5) 4.46 %compared to the STB (100%) nutrient treatment (T_1), respectively.

Improvement of existing cropping pattern through nutrient rich lentil varieties in lentil-T.*aus* T.*aman* cropping pattern

The experiment was conducted at at the Research field of Agronomy Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during 2018-19 To To find out suitable variety of lentil for lentil-T.aus-T.Aman cropping pattern to find out suitable variety of lentil for lentil-T.aus-T.Aman cropping pattern and productivity in rice based cropping pattern along with maintaining nutritional security . The treatments were T_1= Lentil (BARI Masur-3)- T. *aus* (BRRI dhan48)-T. *aman* (BRRI dhan62),T_2= Lentil (BARI Masur-6)- T. *aus* (BRRI dhan48)-T. *aman* (BRRI dhan62), T_3= Lentil (BARI Masur-7)- T. a*us* (BRRI dhan48)-T.Aman (BRRI dhan62),T_4= Lentil (BARI Masur-8)- T.Aus(BRRI dhan48)-T.Aman (BRRI dhan62), T_5= Lentil (BARI Masur-9)- T. *aus* (BRRI dhan48)-T. *aman* (BRRI dhan62). The trial was set up in randomized complete block design with three replications. The unit plot size was 4.8 m × 3.6 m. Fertilizers were applied as per treatments in the form of Urea, Triple super phosphate (TSP), Muriate of potash (MoP) Gypsum, zinc sulphate and Boric acid, respectively. The results showed that the highest rice equivalent yield (REY) and gross return were obtained in T_2 (5.76t/ ha, Tk. 649500.00 /ha), T_3 (5.50 t/ha, 631742.90) and T_4 (5.63 t/ha, 646551.23), respectively. The T_2 treatment showed the highest gross margin and BCR (3.30) also. The highest amount of protein was found in T_2 (26.63%) and the lowest was found in T_3 (23.75%). The highest amount of zinc and iron were obtained from T_5 (92 and 95ppm) and the lowest was found in T_1. Although T_2 produce the height BCR, T_5 is the best in terms of zinc and iron. So T_2, T_3 and T_4 may be recommended for nutritional security of Bangladesh. So, it is clear that these improved cropping patterns suggest a great opportunity to increase cropping intensity and ensure sustainable food and nutrition security especially in the context of Bangladesh.

Estimation of temperature co-efficient of wheat for adjusting proper sowing time

The field experiment was conducted at Agronomy Research Field, Joydebpur, Gazipur and ARS, Rajbari, Dinajpur of Bangladesh Agricultural Research Institute during rabi of 2019 – 2020 to observe the growth behavior and yield of wheat as influenced by prevailing air temperature as well as other weather elements based on sowing time. The treatments were five sowing dates: D_1 = 10

November, D_2 =20 November, D_3 = 30 November, D_4=10 December and D_5=20 December.The experiment was laid out in a RCB design with three replications and the unit plot size was 5m × 4m in both locations. Wheat seeds were sown as per treatment in line with maintaining 20 cm row to row spacing. Fertilizers were applied @ 120-30-90-15-3-1 kg/ ha of N-P-K-S-Zn-B, respectively, in the form of urea, TSP, MoP, gypsum, zinc sulphate and boric acid. Sowing date showed great influence on total dry matter (TDM) production, leaf area index (LAI), physiological maturity, yield and yield components of wheat. The 30 November sowing produced the maximum TDM and LAI followed by 20 November sowing. These parameters finally contributed to higher grain yield than earlier and later sowing date. The 30 November sowing took the longest period (107 days and 112 days at Joydebpur and Rajbari, respectively) to attain the physiological maturity with the highest growing degree day (GDD) (1636 and 1614 at Joydebpur and Rajbari, respectively) and 20 December sowing took the shortest period (91 days and 96 days at Joydebpur and Rajbari, respectively) to attain the physiological maturity with the lowest GDD (1499 and 1591 at Joydebpur and Rajbari, respectively). It was also found that 30 November sowing produced the higher grain yield (4.90 t/ha at Joydebpur and 5.26 t/ha at Rajbari).The results revealed that 20-30 November sowing produced higher grain yield might be due to favourable air temperature for growth and development of wheat. Late sowing after November 30 produced lower grain yield due to high temperature prevailed at the later growth stage (during March) of wheat at Joydebpur and Rajbari region. The temperature co-efficient of wheat was estimated at 2.65 t/ha decreased per increasing 1^0C air temperature. Effect of temperature on the grain yield of wheat was estimated at 82-85%.

Potentiality of BARI released tomato varieties under late planting condition in Dinajpur

An experiment was conducted at ARS, Rajbari, Dinajpur to observe the effect of planting date and variety on the yield of late production of tomato. The potentiality of fruit setting in the late season were evaluated for BARI tomato-15, 16 and one local variety by planting January 15, January 30, February 15 and February 29.The experiment was laid out in a split plot design with 3 replications. Planting dates were assigned in the main plot and varieties in the sub-plot. The unit plot size was 2.4 m × 2 m. Thirty days old seedlings were transplanted maintaining 60cm × 40cm spacing between and within rows. The crop was fertilized with 10 tons of cowdung and 100-34-104-27-1.5-1.3 kg/ha N-P-K-S-Zn-B through urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. A combination of January 15 planting with BARI Tomato -16 variety performed better in respect of yield (64.72 t/ha). The variety BARI Tomato-16 also showed potential fruiting capability during late winter season and February 30 planting produced 38.29 ton/ha of yield.

Limited water management in sweet gourd cultivation

The experiment was conducted at the Research Field of Agronomy Division, BARI, Joydebpur during rabi seasons of 2018-2019 and 2019-20 to develop irrigation scheduling for sweet gourd in dry/upland area of Bangladesh and also to reduce the cost for irrigation water in sweet gourd cultivation. Treatments were as T_1 = Four irrigations at 10 DAT + 35 DAT + 55 DAT + 75 DAT,T_2 = Limited water use with two inlet at 10 days interval upto 25 days before harvest,T_3 = Limited water use with three inlet at 10 days interval upto 25 days before harvest, T_4 = Limited water use with two inlet at 15 days interval upto 25 days before harvest,$T_{5=}$ Limited water use with three inlet at 15 days interval upto 25 days before harvest and T_6 = No irrigation (control).The results revealed that the highest sweet gourd yield (28.92 t/ha for 2018-19 and 30.15t/ha for 2019-20) was recorded in T_1 (Four irrigations at 10 DAT + 35 DAT + 55 DAT + 75 DAT upto harvest) treatment. Among the limited water treatments, T_5 (Limited water use with three inlet in 15 days interval upto 25 days before harvest) treatment produced the highest yield ((27.41t/ha in 2018-19 and 28.76 t/ha in 2019-20).This treatment showed more chlorophyll content and dry matter accumulation. Higher irrigation water use efficiency (IWUE) 0.16 was recorded in T_5 (Limited water use with three inlet at 15 days interval upto upto25 days before harvest) and the lowest (0.05) in T_1 (Four irrigations at 10 DAT + 35 DAT + 55 DAT + 75 DAT) treatment. The highest gross return Tk. 289200.00/ha in 2018-19 and Tk.301516.67/ ha in 2019-20 and BCR 2.64 in 2018-19 and 2.68 in 2019-20 were obtained from T_1 (Four irrigations at 10 DAT + 35 DAT + 55 DAT + 75 DAT upto harvest) treatment. Though the highest BCR was recorded in T_1 treatment but it required higher irrigation water. Although T_1 andT_5 produced identical yield, respectively but T_5 required less water as compared to $T_{1.}$ From the study it concluded that limited water use with three inlet at 15 days interval upto25 days before harvest (T_5) would be effective for irrigation water and maximize the yield.

Effect of plant spacing on potato under zero tillage mulch condition in southern coastal region of Bangladesh

The experiment was carried out under ACIAR-KGF project at farmers' field of Tildanga village, at Dacope Upazila under Khulna District and Bandra village, Amtali Upazila under Barguna District during *rabi* season of 2019-2020 after harvest of previous T. *aman* rice to determine the effect of plant spacing on potato under zero tillage mulch condition in coastal saline region of Bangladesh. The experimental area faces slight to moderately drought and saline prone at latter part of winter season and beginning of summer. The salinity causes unfavorable environment and hydrological situation restricting the normal crop production. Farmers generally cultivate only single transplanted aman (T. *aman*) rice in a year in south and south-western coastal saline areas. Four treatments of the experiment were T_1 = 60 cm ×25 cm, T_2 = 50 cm ×25 cm, T_3 = 40 cm ×25 cm and T_4 =30 cm ×25 cm. The experiment was laid out in a randomized complete block design with three replications. Seed tuber of potato (var. BARI Alu-72) was sown on 17 December 2019 at Dacope Upazila and on 14 December 2019 at Amtali Upazilla under zero tillage straw mulch condition following the treatment specification. The unit plot size was 3 m x 4 m at Dacope and 5 m × 4 m at Amtali. The experimental plot was fertilized with recommended nutrient plus 20% extra K (N-P-K-S-Zn-B @ 135-30-108-10-2-1 kg/ha).Plant spacing had significant effect on all studied characters of potato except plant height at Amtali. The highest number of tuber/m^2 (104) and tuber yield (20.38 t/ha) were obtained from the closer plant spacing (30 cm×25 cm) although the highest plant height, number of tuber/hill and single tuber weight were found in higher spacing (60 cm×25 cm) and 50 cm×25 cm) at Dacope, Khulna. The lowest tuber yield (13.76 t/ha) was obtained from recommended spacing of potato (60 cm × 25 cm). Economic performance was also found better in closer spacing with higher BCR and monetary returns. Similarly closer plant spacing (30 cm × 25) produced higher tuber yield (15.20 t/ha) at Amtali. Application of straw mulch conserved the soil moisture and reduced salinity stress. Potato cultivation with closer spacing (30 cm × 25 cm) at both the locations under zero tillage mulch condition was found suitable for managing soil salinity in southern coastal region. Application of straw mulch might conserve soil moisture and reduced salinity stress. Potato cultivation after T. *aman* rice in *rabi* season in southern coastal region that could help to crop intensification in saline area and ultimately fallow land could be utilized after T. *aman* rice.

Performance of garlic varieties under zero tillage and mulch conditions in southern coastal region of Bangladesh

The experiment was carried out under ACIAR-KGF project at farmers' field of Tildanga village at Dacope Upazila under Khulna District and at Bandra, Amtali, Borguna district during rabi season of 2018-2019 and 2019-2020 after harvest of previous transplanted aman rice to find out suitable variety of garlic (Allium sativum) for cultivation under zero tillage straw mulch condition in southern coastal region of Bangladesh. The experimental area faces slight to moderately drought and salinity stress at latter part of winter season and beginning of summer. The salinity causes unfavorable environment and hydrological situation restricting the normal crop production. Farmers generally cultivate only single transplanted aman (T. *aman*) rice in a year at south and south-western coastal saline areas. Garlic is one of the important spices crop in Bangladesh. The treatments of the experiment were five garlic varieties viz., V_1 = BARI Roshun-1, V_2 = BARI

Roshun-2, V_3 = BARI Roshun-3, V_4 = BARI Roshun-4 which were developed by Bangladesh Agricultural Research Institute (BARI) and V_5= Local cultivar (Italic). The experiment was laid out in a randomized complete block design with three replications. All five varieties of garlic were planted on 17 December 2018 and 18 December 2019 at Dacope, and 15 December 2019 at Amtali under zero tillage straw mulch condition. The unit plot size was 3 m x 4 m. The plant spacing was 20 cm × 10 cm and covered with straw mulch (6-8 cm high) after planting. The experimental plot was fertilized as per recommendation (160-50-125-27-5-3 kg/ha of N-P-K-S-Zn-B) (BARI, 2006). The results revealed that BARI Roshun-4 gave the highest bulb yield followed by BARI Roshun-1 in 2019-2020 but BARI Roshun-1 gave the highest bulb yield in 2018-2019. On economic point of view, BARI Roshun-4 is more suitable indicating higher profitability (BCR of 3.18). It was also observed that the soil moisture of the farmers' field was higher during sowing of garlic which was not suitable for ploughing the land. So, timely establishment of garlic is possible by following hand dibbling methods under zero tillage condition in the moist soil surface. Mulching can protect the evaporation loss and reduces the salinity stress which ultimately influence the crop establishment and yield. Earlier farmers of Tildanga village at Dacope Upazila under Khulna District had no idea about the cultivation of garlic under zero tillage along with straw much. When the experimental results were demonstrated and discussed about the technology to the farmers gathering during Field visit and Field Day then they were impressed and interested to grow garlic. Fallow land of coastal areas of Bangladesh could be utilized through disseminating this technology and ultimately cropping intensification would be increased.

Screening of different chilli germplasm in waterlogging condition

An experiment was conducted at the research field of Regional Agricultural Research Station, BARI, Cumilla during *kharif* season of 2019-20 to find out suitable water logging tolerant chilli germplasm for cultivation in low lying area. The experiment was conducted in randomized complete block design with 10 genotypes and four treatments; T_1=24 hours, T_2=48 hours, T_3=72 hours water logging stress condition and T_4=Control.The unit plot size was 3m × 2m. The genotypes were collected from different farmer's field of Cumilla. Seed was sown in seed bed on 6 May 2020. Seedling was transplanted on 5 June, 2020. Rows were 50 cm and plants were 30 cm apart from each other. Fertilizers were applied @ 120-80-60-40-4-1 kg/haof NPKSZn and B from urea, TSP, MoP, gypsum, zinc sulphate and boric acid, respectively. All of the genotypes were finally resulted mortality due to water logged condition. Although the genotype CF 006 showed the highest survival time at all stress condition.

Nutrient management for mustard as relay crop with T. *Aman* rice under ganges tidal floodplain

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during the *rabi* season of 2019-2020 to develop nutrient management package for mustard as relay crop with T.aman rice under Ganges Tidal Floodplain. The treatments of the experiment were: T_1 = 100% Recommended dose (RD: 90-27-16-15-1.5-1-1 kg/ha N-P-K-S-Mg-Zn-B), T_2 = 75% of RD, T_3 = 50% of RD, T_4 = 25% of RD, and T_5 = Nutrient dose on soil test based (STB) result. The variety of mustard was BARI Sarisha-14. Mustard seeds were sown through broadcasting method on 26 November, 2019 as relay crop with previous T.aman rice (var. BRRI dhan11).The variety of mustard was BARI Sarisha-14. Mustard seeds were sown through broadcasting method on 26 November, 2019 as relay crop with previous T.*aman* rice (var. BRRI dhan11). Seed rate for mustard was 6 kg/ha. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 5 m × 4 m. The initial soil moisture was 32% on oven dry basis. Before seeding soil samples of the experimental plots were taken for plant nutrient determination in the laboratory.The experimental plots were fertilized as per the treatment specifications for relay mustard crop. Fertilizer dose for previous T.*aman* rice was: 75-10-18-4-1 kg/ha N-P-K-S-Zn, respectively. The soil test base fertilizer dose for mustard was 72-22-13-12-0.8-0.8 kg/ha N-P-K-S-Zn, respectively. Experimental results revealed that nutrient management package had significant effect on plant height, number of siliqua/plant, 1000-seed weight and seed yield. The highest yield was recorded in T_1 treatment (1235 kg/ha), which was partially at par with that of T_2 (1183 kg/ha) and T_5 (1112 kg/ha). The lowest yield was obtained from T_4 (613 kg/ha). The economic analysis results showed that the gross return became the highest (Tk. 75161/ha) in T_1 (100% RD) and it was similar (Tk.72024/ha) with that of T_2 (75% RD). Similarly, the gross margin was found to be the highest (Tk. 22518/ha) in T_1 followed by T_2 (Tk. 21452/ha). The value of benefit cost ratio (BCR) was the highest (1.43) in T_1 followed by T_2 (1.42) and T_5 (1.33). Although the grain yield was slightly higher in T_1 (100% RD) than that of T_2 (75% RD) but from the economic point of view treatment T_2 might be applied for cultivation of mustard as relayed with T.aman rice under Ganges Tidal Floodplain. This was the first year experiment and therefore final recommendation will be made by repeating the experimentation in the next year.

Integrated nutrient management for cucurbits on floating bed cum trellis

The experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal on cucurbits (pumpkin and bottle gourd) during *Kharif* season (pumpkin) and Rabi season (bottle gourd) during2019-2020. The floating bed was prepared with water hyacinth and water fern (topapana) before transplanting of cucurbit seedlings. The treatments for both pumpkin and bottle gourd comprised of five treatments (fertilizer doses) viz., T_1 = 71g urea, 180g diammonium phosphate, 40g muriate of potash, 44g gypsum, 3g zinc sulphate, 6g boric acid/10 sqm area; T_2 = 75% of T_1; T_3 = 50% of T_1, T_4 = 25% of T_1, and T_5 = No fertilizer (control). The experiment was laid out in randomized complete block design with three replications. The unit plot (sub floating bed) size was 1.5 m × 1.2 m. The variety of pumpkin was BARI Mistikumra-2 and the bottle gourd variety was BARI Lau-4. The young seedlings (with ball/dolla) of pumpkin and bottle gourd were transplanted on floating bed in two rows on raised pits (2 seedlings/pit and 8 pits/row) on 27 July 2019 and 11 November 2019, respectively. The plant spacing for both the crop was row to row distance 80 cm and plant to plant distance 120 cm. After transplanting of seedling, trellis was made alongside the floating bed with bamboo pole, nylon rope and dhaincha stick. The trellis between two floating bed was 6 meter wide. The floating bed cum trellis (non-tidal model) is suitable for optimum growth and development of the cucurbits or creeper vegetable crop plants. Fertilizers were applied as per the treatment specifications. Nitrogen and phosphorus were applied in the forms of urea and diammonium phosphate, potassium as muriate of potash, sulphur as gypsum, zinc as zinc sulphate and boron was applied in the form of boric acid. All the chemical fertilizers were applied on the floating bed in liquid form (through mixing with water) and applied at surrounding the crop plant or root zone in five equal splits at 15, 25, 35, 45 and 55 days after seedling transplanting. Pumpkin crop was harvested on 27 October, 2019 and the final harvest date of bottle gourd was 9 March, 2020. In terms of pumpkin yield, T_2 treatment produced the highest yield (19.16 t/ha), which was statistically similar with that of T_1 (18.55 t/ha). The results further indicated that T_2 and T_1 increased the yield 42.71% and 38.16%, respectively over the control. On the other hand, treatment T_1 gave the highest yield of bottle gourd (76.53 t/ha), which was statistically at par with that of T_2 (76.02 t/ha). It was observed that T_1 and T_2 treatments increased the fruit yields 55.69% and 54.66%, respectively over the control. It might be concluded that treatment T_2 (53g urea, 135g diammonium phosphate, 30g MoP, 33g gypsum, 2g zinc sulphate,4g boric acid per 10 sqm area) can be applied for pumpkin and bottle gourd cultivation on floating bed cum trellis for increasing the yield of the crops. However, as the experiment was the first year, the experiment should be repeated in the next year for final recommendation.

Development of floating bed cum trellis (tidal model) for creeper vegetables cultivation under tidal flooded ecosystem of Bangladesh

The experiment was conducted during rabi season of 2019-2020 in the tidal prone areas at Boithakata village under Nazirpur upazila of Pirojpur district of Bangladesh to develop floating bed cum trellis (tidal model) for creeper vegetables cultivation under tidal flooded ecosystem of Bangladesh. The experiment was comprised of two types of floating bed viz., S_1 = Water hyacinth based floating bed cum trellis (tidal model): Trellis was made of GI tar and nylon net connected with floating foundation and opposite bamboo poles; and S_2 = Traditional floating bed. The floating bed was prepared with water hyacinth and water fern (topapana) before transplanting of cucurbit seedlings. The experiment was laid out in randomized complete block design with three replications. The size of the whole floating bed (block) was 9.15 meter long (30 feet), 1.37 meter wide (4.50 feet) and 1.16 meter (3.80 feet) high.The GI made trellis between two floating bed was 6 meter wide. The creeper vegetable crop grown on floating bed was pumpkin and the variety was BARI Mistikumra-2. Seedling of pumpkin was transplanted on floating bed on 27 September 2019. Fertilizer nutrients were applied as per the recommended dose (@ 53g urea, 135g diammonium phosphate, 30g muriate of potash, 33g gypsum and 4g boric acid/10 m^2). All the chemical fertilizers were applied on the floating bed in liquid form (through mixing with water) surrounding the crop plant or root zone in five equal splits. Results revealed that the average fluctuation of water was 36.65 cm in October 2019, 25.13 cm in November 2019 and 24.28 cm in December 2019 in the experimental field due to high and low tides. The effect of type of floating bed was significant in terms of vine length, number of fruit/plant, number of fruit/bed, fruit length, fruit breadth, single fruit weight, fruit weight/bed and fruit yield. The higher values of these parameters were found in water hyacinth based floating bed cum trellis (FBT-tidal model) followed by traditional floating bed. The fruit yield was 10.21 t/ha in floating bed cum trellis, while 5.13 t/ha yield was found in traditional floating bed. Creeper vegetables could be cultivated through floating bed cum trellis (tidal model) under tidal flooded ecosystem of Bangladesh. However, the experiment should be repeated in the next year for final recommendation.

Screening of foxtail millet under rainfed condition in char land

The experiment was conducted at the charland area of Jamalpur during *rabi* 2019 to identify the suitable foxtail millet line/verity for water stress and increase production area of char land. Treatments included in the experiment were: ten different lines and one variety (BARI Kaon-1). T_1 = RC-170, T_2 = BD-869, T_3= BD-954, T_4= BD-972, T_5= BD-998, T_6= BD-1062, T_7= BD-1075, T_8= BD-1083, T_9= BD-1086, T_{10}= BD-1108 and T_{11}= BARI Kaon-1. Design of the experiment was RCB with 3 replications. Millet lines/varieties were sown in unit plot having 2m × 2m with the spacing of 30 cm × continuous sowing. Fertilizers were applied at the rate of 42-15-32-7-1 kg/ha NPKSZn as urea, triple super phosphate (TSP), muriate of potash (MOP), gypsum and boron, respectively. Considering phenological and yield contributing characters such as days to flowering and harvest, effective tiller per hill, panicle length, root length, 1000- grain weight and yield, foxtail millet line, BD-1086 performed better in rainfed condition especially in char land area.

Performance of minor spices at char land of Jamalpur

The experiment was conducted at the charland area of Jamalpur during rabi 2019-2020 to observe the yield performance of minor spices at charland. Treatments included in the experiment were: BARI Kalojira-1, BARI Methi-1, BARI Methi-2, BARI Dhania-1, BARI Dhania-2, BARI Mouri-1, BARI Mouri-2 and Dill (Soluk) - Local. The experiment was laid out in a RCB design with 3 replications. The unit plot size was 2m × 2m. All the minor spices which were produced in char land area well performed in terms of emergence percentage, number of pod or umbel/plant, number of seed /pod or umbel, 1000- seed weight and yield. Char land might be selected to produce minor spices for full fill the demand of our country and save foreign currency.

Performance of sweet potato varieties at char land in Rangpur

A field trail was conducted at Mohipur char, Rangpur with four varieties (BARI Sweet potato-4, BARI Sweet potato-8, BARI Sweet potato-13 and BARI Sweet potato-14) of sweet potato to find out the yield performance in char landduring rabi season 2019-20.The size of the unit plot was 4 m × 5m. Weeding, irrigation and spraying were done as required. Fertilizers were applied at the rate of 280-170-260-80-12-8 Kg/ha of Urea-TSP-MP-gypsum-zinc sulphate-boric acid, as respectively. The highest yield was observed in BARI Sweet potato-8 and it was at par with BARI Sweet potato-4. Among the varieties of sweet potato, BARI Sweet potato-4 and BARI Sweet potato-8 showed better performance and would be grown in char land area.

Performance of potato varieties at char land in Rangpur

A field trail was conducted at Mohipur char, Rangpur with five varieties (BARI Alu-36, BARI Alu-37, BARI Alu-40, BARI Alu-41, BARI Alu-13) of potato to find out the yield performance compare to other verities in char landduring rabi season 2019-20. The size of the unit plot was 4 m. x 5m. Fertilizers were applied at the rate of 350-220-250-120-10-8 Kg/ha of Urea-TSP-MP-gypsum-zinc-boron, respectively. The highest yield was observed in BARI Alu-41 which was statistically identical with that of BARI Alu-36 and BARI Alu-40. Among these BARI improved variety of potato, BARI BARI Alu-41 was showed better performance in char land area.

Demonstration of hybrid maize + potato intercropping

A demonstration was conducted at farmers field of Gangachara, Rangpur and Chandina, Cumilla to evaluate the performance of maize+ potato intercropping technology. The size of the unit plot was 16 decimal. The spacing of potato and maize were maintained 60 cm x 25 cm. The fertilizer for potato and maize were used as per recommended dose. Maize was sown in potato row after 26 days after potato sowing that means final earthing up of potato. Maize+ potato intercropping showed good performance and gave better economic return (gross margin Tk. 218500-295000 /ha and BCR: 2.01-2.20) during rabi season 2019-2020. The yield of sole maize was lower (9.89-10.90 t/ha) than maize +potato intercropping in terms of maize equivalent yield (21.80-27.08 t/ha). Farmers showed interest to cultivate maize+ potato intercrop for higher productivity and returns.

Demonstration of hybrid maize-pea intercropping at char land of Jamalpur

The demonstration program was conducted at Nawvanger char, sadar, Jamalpur during 2019-2020 to evaluate the performance of maize+ pea intercropping technology in farmer’s field.The size of the unit plot was 16 decimal. The spacing of potato and maize were maintained 60 cm x 25 cm. The fertilizer for potato and maize were used as per recommended dose. Maize was sown in potato row after 26 days after potato sowing that means final earthing up of potato. Maize+ pea intercropping showed good performance (maize equivalent yield:15.53 t/ha) and gave better economic return (gross margin Tk. 236680/ha and BCR: 3.25) during rabi season 2019-2020. The yield of sole maize was lower (10.50 t/ha) than maize +pea intercropping in terms of maize equivalent yield (15.53 t/ha).

Survey and identification of major weed species of potato in Dinajpur

A survey on weed in potato field was carried out at out at i. Ranigong union, ii. Chehelgazi union and iii. Shakhpura union during rabi season of 2019-20 to identify the major weed species associated with potato in Dinajpur (AEZ 1). Total 40 farmer’s field were randomly selected from each location for data collection. Variability of weed species were observed from each location. About 40 farmer’s fields were randomly selected per location. Quadrate was used for weed sampling.The maximum number of weed infestation 64/m^2 was found at Raniganj union and the minimum weed infestation 37/m^2 was found at Shekhpura union of Dinajpur Sadar, Dinajpur. The grass types of weeds such as *Chenopodium album* (Bathua), *Cynadon dactylon* (Durba), *Rumex maritimus* (Ban Palong), *Eleusine indica* (Chapra) and *Cyperus rotundus* (Mutha) were found dominant at Ranigonj union. However, Bathoya and *Gnaphalium affine* (Bon copi) was dominant at Chehelgazi union. But the grasses of Durba, Bathua, Jharadhan, Chapra and Mutha were also found dominant at Shakhpura union.

10 IRRIGATION AND WATER MANAGEMENT

Background

Irrigation and Water Management Division is one of the full-fledged research divisions of Bangladesh Agricultural Research Institute. The divisionis associated with conducting research on various aspects of irrigation and water management practices for upland crops, water management techniques for saline soils, adaptation to impacts of climate change, micro-irrigation systems, and development of irrigation systems for hilly areas. It generates information through conducting research on water quality, agricultural drainage, as well as on pumps and tube wells for both ground and surface and groundwater. It has developed and disseminated several water saving irrigation technologies for drought and salinity prone areas of Bangladesh. It is contributing to enhance crop productivity and sustainability in water management through proper scheduling of irrigation practices for major crops, providing innovative solutions to save water for irrigating crops, and disseminating the developed technologies among the beneficiaries (end users). As of yet, the division has developed and demonstrated about 50 irrigation and water management technologies. A considerable number of these technologies have been used by the farmers in different parts of Bangladesh.

Daily and multi-step ahead forecasting of potential evapotranspiration using machine learning algorithms with limited climatic data

Accurate prediction of potential evapotranspiration (ET_0) is essential for efficient planning and management of limited water resources through judicial irrigation scheduling. The FAO-56 Penman-Monteith approach to ET_0 estimation was adopted to compute ET_0 from data obtained during the period 2004–2019 from a weather station located in GazipurSadarUpazilla, Bangladesh. The obtained meteorological variables (e.g., daily maximum and minimum temperatures, wind speed, relative humidity and sunshine duration) and computed ET_0 values were used as inputs and outputs, respectively, for modelling daily and one-step aheadET_0predictions. For modelling,this study evaluates the prediction accuracy and estimation capability of two deep learning algorithms, a Long-Short Term Memory (LSTM) network and a bi-directional LSTM (Bi-LSTM) network. The prediction accuracy of LSTM and Bi-LSTM networks is compared with six commonly used machine learning algorithms, i.e. Adaptive Neuro Fuzzy Inference System (ANFIS), Gaussian Process Regression (GPR), M5 Model Tree, Multivariate Adaptive Regression Spline (MARS), Probabilistic Linear Regression (PLR), and Support Vector Machine Regression (SVR). Ranking of the prediction models is performed using weights calculated by Shannon’s Entropy that accounts for a set of benefit (higher values indicate better model performance) and cost (smaller values indicate better model performance) performance indices. Results revealed that the LSTM model was found to be the best performer followed by Bi-LSTM, GPR, SVR, MARS (piecewise-linear), ANFIS, MARS (piecewise-cubic), M5 Model Tree, and PLR models. In the next stage, a one-step ahead prediction of ET_0 values was conducted using only the past values of ET_0 time series. Four modelling approaches (LSTM, Bi-LSTM, sequence-to-sequence regression LSTM network (SSR-LSTM) and ANFIS) were used for one-step aheadET_0 predictions. Partial Auto Correlation Functions were used to obtain the time-lagged information from the ET_0 time series, and to determine the input and output variables for the LSTM, Bi-LSTM, and

ANFIS models. On the other hand, in SSR-LSTM the responses are the training sequences with values shifted by one time-step. That is, at each time step of the input sequence, the LSTM network learns to predict the value of the next time step. Results of this modelling work revealed the superiority of Bi-LSTM followed by SSR-LSTM, ANFIS, and LSTM models identified by the ranking values computed using Shannon's Entropy. The overall results indicate that the deep learning approaches especially LSTM and Bi-LSTM models could be successfully employed to predict daily and one-step aheadET$_0$ values, respectively.

Historical trends of water usase of major crops and cropping patterns in the north-western districts of Bangladesh

Historical trend analysis of the water usages by major crops and cropping patterns in the drought prone north-western region of Bangladesh can provide valuable information that is useful for future management of irrigation water in wider scale. This study was done to estimate the actual crop evapotranspiration (ET), total and crop-usable effective rainfalls (TER and ER, respectively) and irrigation requirement (IR) of 8 major crops and 8 cropping patterns over historical period (1985 to 2015) by using SWBcropwat model and analyse the trends of these water parameters by using MAKESENS tool for the 16 districts of the region. The results revealed that the ET of the dry season crops and cropping patterns had a significant ($p \leq 0.05$) decreasing trends in all districts. Whereas, the ER decreased significantly for most dry season crops in 4 districts.TER was often greater than ER for monsoon crops, which could not fully utilize TER always because of its non-uniform temporal distributions. IR showed significantly decreasing trend for the dry season crops in 11 districts and increasing trend for the monsoon crops in 5 districts. Although ET and IR decreased in most cases, their total volumetric quantities showed significantly increasing trends due to expanded irrigated area over time.

Optimize fertigation management to minimize nitrate leaching from drip irrigated brinjal field

This research was carried out at the research field of Irrigation and water Management Division (IWM) of Bangladesh Agricultural Research Institute (BARI), Gazipur during 2019-2020 to optimize fertigation management to minimize nitrate leaching from drip irrigated brinjal field. BARI Bt. Brinjal 4 cultivar was used for the experiment. There were four different irrigation treatments comprising two levels of irrigation intervals and two irrigation timings [Drip irrigation at 4-day interval with fertigation at the beginning of the irrigation cycle (T_1), Drip irrigation at 3-day interval with fertigation at the beginning of the irrigation cycle (T_2), Drip irrigation at 4-day interval with fertigation at the end of the irrigation cycle (T_3), and Drip irrigation at 3-day interval with fertigation at the end of the irrigation cycle (T_4)]. It is observed that yield and yield contributing characters were varied significantly among the irrigation treatments. It is also observed that treatment T_4 received highest amount of irrigation (270 mm) followed by the treatments T_2, T_3, and T_1. Modelling results for optimizing fertigation management is not presented in this report due to unavailability of the complete sets of data for modelling at this stage.

Yield and water productivity indices of different onion varieties under sprinkler irrigation

To evaluate the performance of four onion varieties under sprinkler irrigation and their sensitivity to water stress, a study was conducted at the experimental field of IWM Division, BARI during the winter season of 2018-2019. The experiment comprised of five irrigation treatments with sprinkler system based on 60%, 80%, 100%, 120% and 140% of crop water use (ETc) laid out in split-plot design with three replications. Irrigation water was applied at a fixed 6-day interval with sprinkler system throughout the crops growing season. Onion sensitivity to water stress was determined using a yield response factor (Ky) that derived from the linear relationship between relative evapotranspiration deficits (1-ETa/ETm) and relative yield decrease (1-Ya/Ym). Statistical analysis revealed that plant height was not much affected by the level of irrigation while, leaf number, bulb diameter, bulb unit weight and total bulb yield was affected significantly ($P<0.05$) by the irrigation regimes. Among the four onion varieties, the highest plant height, bulb diameter and unit bulb weight contributed to the highest yield of 24.53 t/ha and 34.07 t/ha in first and second year, respectively, for BARI Piaj-4 (V4) followed by 22.04 t/ha and 31.02 t/ha for Taherpuri King (V3) under 120% water regime. Taherpuri super (V2) produced the second lowest yield of 17.73 t/ha in the first year and 25.97 t/ha in the second year which was comparable to the lowest yield of 16.57 t/ha and 24.60 t/ha produced by the variety BARI onion -1 (V1). Value of Ky determined for the whole growing season was found higher for V4 (Ky: 1.12) and V3 (Ky: 1.13) than other two varieties (0.85 for V1 and 0.87 for V2) indicates that both varieties V4 and V3 are highly sensitive to water stress. This fact is also evident by the water productivity (WP) with higher values obtained under higher water regimes (120% ETc) in case of V4 and V3; but for other varieties, higher WP was obtained from 80% ETc water regime. The amounts of water used for evapotranspiration under different irrigation regimes ranged from 151 to 253 mm, 153 to 256 mm, 158 to 260 mm and 161 to 262 mm, respectively, for V1, V2, V3 and V4 in the year 2018 - 2019 and 163 to 268 mm, 165 to 270 mm, 168 to 272 mm and 167 to 272 mm in the following year with minimum at 60% ETc and maximum at 140% ETc water regime. Though seasonal evapotranspiration was higher under wetter water regimes, yield was somewhat lower and consequently WP was the lowest. Considering Ky as a limiting factor, application of irrigation at 80% ETc was a marginal for V1 and V2 and 100-120% ETc for V3 and V4, beyond that yield losses are insupportable.

Effect of fertilizer and irrigation frequency on the yield and quality of export and processing potato

Fertilization and irrigation plays a crucial role in enhancing system productivity of potato. To achieve improvement in maximize dry matter (DM) and quality of potato tuber in relation to combined fertilization and irrigation, are needed. We hypothesized that fertilization and irrigation frequency influence growth patterns, distribution of dry matter in different parts of potato plants and quality of potato tubers. To test this hypothesis, an experiment was conducted at the research field of Irrigation and Water Management Division of the Bangladesh Agricultural Research Institute, Gazipur, and evaluated dry matter partitioning, tuber yields, water use and water productivity and quality of two export and processing potato varieties of BARI Alu-25 (V_1) and BARI Alu-29 (V_2) in different fertilization and irrigation treatments. The treatments consisted of nine combinations of three fertilizers levels and three irrigation levels. Three fertilizer levels were **(i)** F_1: FRG 2018 (Split 2 times: N, K) (ii) F_2: FRG 2018 with combination of SOP (Split 3 times: N, SOP, Mg), (iii) F_3: FRG 2018 with combination of SOP (20% Additional) (Split 2 times: P, 3 times: N, SOP, Mg. Three irrigation frequency were (i) I_1: 3 irrigation (20-25 DAP, 40-45 DAP, 60-65 DAP), (ii) I_2: 4 Irrigation (18-20 DAP, 40-42 DAP, 55-60 DAP, 70-75 DAP) and (iii) I_3: 5 Irrigation (17-20 DAP, 32-35 DAP, 50-52 DAP, 62-65 DAP, 78-80 DAP). The results indicate that fresh tuber yields of potatoes (V_1 and V_2) were not significantly different among the treatments. The treatment F_2 produced greater tuber yield of both variety of V_1 and V_2 relative to F_1 and F_3. The interaction of fertilizer and irrigation was not significant differences on total dry matter (tdm) of potato in V_1 and V_2. At harvesting stage, there was greater tdm per plant in F_2 than F_1 and F_3. In the I_2 treatment, there was also greater tdm per plant in V_1 and V_2 than I_1 and I_3. Dry matter partitioning in root, stem, leaf and tuber of potato plants as influenced by treatments at different growth stages. At harvesting stage, the interactive effect of F_2 and I_2produced greater tuber dry matter per plant than the interactive effect of $F_1I_2$and F_3I_2 in V_1 and V_2. Water productivity varied among the treatments from 7.2 to 13.15 kg m^{-3}. The combination of F_2 and I_2 system noticeably resulted in the highest WP in both varieties than other interactive treatments. The quality parameters of potato tubers (TSS, reducing sugar content, starch content, firmness, color, crispness) were not reported due to incomplete analysis. These results are of considerable importance to export and processing potato growers to achieve more efficient use of fertilizer and water by processing potato grown in availability environments of Bangladesh.

Potentiality of biochar to enhance productivity of tomato under deficit irrigation

This study was conducted at the research field of Irrigation and water Management Division (IWM) of Bangladesh Agricultural Research Institute

(BARI), Gazipur during 2017-2018, 2018-2019, and 2019-2020 to examine the potentiality of biochar in improving productivity of tomato cultivated under deficit irrigation regimes, and the effects of biochar on some soil properties. BARI Tomato-14 cultivar was used for the experiment. There were six different irrigation treatments comprising three level of irrigations and two soil conditions [full irrigation (FI), 75% of FI and 50% of FI with biochar (T_1 to T_3) and without biochar (T_4 to T_6)]. It is observed that plant height at different growth stages was lower in deficit irrigation (full irrigation > 75% irrigation > 50% irrigation). However, plant height was significantly higher in treatments with biochar compared to the non-biochar treatments (T_1>T_4, T_2>T_5 and T_3>T_6). In contrast to the plant height, root length was found higher in non-biochar treatments (T_4, T_5, T_6) than that of their parallel biochar treatments (T_1, T_2, T_3). Again, both wet and dry biomass weights were found highest in T_1, where the lowest values of both of these attributes were found in T_6. Moreover, the number of fruit per plant, unit fruit weight and the marketable yield in different treatments followed the usual trend, higher in biochar treatments, and reduced significantly as lesser amount of irrigation was applied. About 3-4%, 6-7% and 9-10% higher marketable yield of tomato was observed in T_1, T_2 and T_3 compared to T_4, T_5 and T_6, respectively. As less amount of irrigation water was applied in deficit irrigation treatments, water productivity (WP) showed an increasing trend with the increase in irrigation deficiency. Nonetheless, an improvement of WP by around 4-6%, 8-11% and 11-12% was observed in T_1, T_2 and T_3 compared to T_4, T_5 and T_6, respectively. It was also observed that the soil moisture content dropped sharply in non-biochar treatments under deficit irrigation regimes compared to the treatments with biochar. Overall, biochar addition in the soil helped improve the growth and yield of tomato grown under deficit irrigation regimes, as well as the water holding capacity, N-status and heterotrophic respiration of the soil.

Effect of irrigation on growth, flowering and corm production of gladiolus in winter season

The experiment was conducted at the experimental field of IWM Division, BARI, Gazipur during 2018 -2019 and 2019-20 to evaluate the effect of different irrigation systems and scheduling on the performance of gladiolus. Nine treatments were designed for the experiment with four replications. Treatments were T_1 = Drip irrigation at 3-days interval with recommended N doses, T_2 = Drip irrigation at 3-days interval with 20% less N than recommended doses, T_3 = Drip irrigation at 3-days interval with 40% less N than recommended doses, T_4 = Shower irrigation at 7days interval with 100% of FC, T_5 = Shower irrigation at 7-days interval with 80% of FC,T_6 = Shower irrigation at 7-days interval with 60% of FC,T_7 = Flood irrigation at 10-days interval, T_8 = Flood irrigation at 15-days interval, T_9 = Flood irrigation at 20days interval. Results of experimental findings revealed that the drip system of irrigation i.e. (T_1, T_2, T_3) showed best performance than shower (T_4, T_5, T_6) and flood irrigation (T_7, T_8, T_9) system. Spike yield (22.42 t/ha, 22.55 t/ha), weight of single spike (84.07 gm, 85.08 gm), spike length (104.67 cm (2nd highest), 104.83 cm), rachis length (54.46 cm, 54.03 cm) at both the years were achieved maximum with gravity drip irrigation at 20% less N than recommended doses which were competitive with other two drip irrigation treatments along with shower irrigation with 100% of FC and 80% of FC at 7-days interval. Maximum yield of corms (1.04 t/ha) and cormel (0.94 t/ha, 1.09 t/ha) number of cormels per plant (33.50, 41.25) and weight of cormels per plant (12.33 gm, 11.82 gm) at both the years and weight of single corm per plant (43.71 gm), diameter of corm (6.2 cm) at 2018-19 were accomplished with gravity drip irrigation at recommended N doses at 3 days interval which was competitive with drip irrigation at 20% less N than recommended doses along with shower irrigation with 100% of FC and 80% of FC.. Whereas, the minimum plant growth, spike yield attributes, corm and cormel yield parameter were achieved with shower irrigation with 60% of FC along with flood irrigation at 10-days, 15-days and 20-days interval. The results of the study showed that the lowest irrigation water use, highest water productivity, and water and N savings through drip irrigation system, or shower irrigation with 100% of FC and 80% of FC promotes flower growth and quality characters and corm production of gladiolus in comparison with optimal, or scarce water applied through shower or flood irrigation system.

Effects of saline water irrigation with different doses of potassium on crop growth and yield of mung bean

The experiment was conducted at the shade house of IWM Division, BARI, Gazipur during 2018 - 2019 to evaluate the effect of saline water irrigation with different doses of potassium on Crop Growth and Yield of mung bean. Thirteen treatments were designed for the experiment with four replications. Treatments were T_1= Irrigation with fresh water with 100% potassium, T_2= Irrigation with (4 ds/m) saline water with 0% potassium, T_3= Irrigation with (4 ds/m) saline water with 100% potassium, T_4= Irrigation with (4 ds/m) saline water with 125% potassium, T_5= Irrigation with (4 ds/m) saline water with 150% potassium, T_6= Irrigation with (8 ds/m) saline water with 0% potassium, T_7= Irrigation with (8 ds/m) saline water with 100% potassium, T_8= Irrigation with (8 ds/m) saline water with 125% potassium, T_9= Irrigation with (8 ds/m) saline water with 150% potassium, T_{10}= Irrigation with (12 ds/m) saline water with 0% potassium, T_{11}= Irrigation with (12 ds/m) saline water with 100% potassium, T_{12}= Irrigation with (12 ds/m) saline water with 125% potassium, T_{13}= Irrigation with (12 ds/m) saline water with 150% potassium. Results of experimental findings revealed that potassium fertilization can eliminate the deleterious effects of salinity on mung bean yield to some extent. Additional K application with saline irrigation water significantly affected plant height, root height, number of leaves, plant fresh weight and dry weight of mung bean.

Effect of irrigation on mango fruit cracking in chattogram region

The study was conducted at existing HRC Mango Orchard of Regional Agricultural Research Station, Hathazari, Chattogram during the Rabi season of 2019-20 to explore the optimal period of irrigation to mitigate mango fruit cracking. Five treatments were applied: T_1 (rain-fed i.e. local practice), T_2 (irrigation at flowering stage), T_3 (irrigation at fruiting stage), T_4 (irrigation at flowering and fruiting stages T_5 (irrigation at 2 weeks interval),). The highest yield (76.5Kg plant^{-1}) was found at higher frequency irrigation (T_5). The maximum irrigation (2000 litres plant^{-1}) was applied at two weeks interval irrigation (T_5). In rain-fed condition (T_1), yield was lowest (56.8Kg plant^{-1}). The lowest number of fruits dropping (21no.fruits) was occurred in irrigation at flowering and fruiting stages (T_4). The lowest number of cracking (15no.fruits) as well as the highest sweetness (TSS=24%) occurred irrigation at fruiting stage (T_3) and the benefit-cost ratio was also higher in this treatment.

Conjunctive use of fresh and saline water in irrigation for wheat, barley and mustard in coastal areas of Bangladesh

Conjunctive use of fresh water (low-saline) and saline water (medium saline) for irrigation is a strategy to irrigate rabi crops in the coastal salt affected areas of Bangladesh where fresh water is not available. In this study, the objectives were to assess the effect of fresh water (FW) and saline water (SW) irrigation on the crop performances, and the scope of fresh and saline water irrigation for rabi crops. Three field experiments were laid out in a randomized complete block design with four irrigation treatments for wheat, barley and mustard, and replicated thrice during 2018-2019 and 2019-2020. These field experiments were conducted in farmers' fields at Sikandorkhali village, Amtaliupazila in Barguna and Tildanga village, Dacopeupazila in Khulna districts. Standard crop management practices and irrigation scheduling of different crops were followed. Results showed that the use of FW at early growth stages and SW at later growth stages had significant difference. Treatment T4 (FW at early stage and SW at later growth stages of wheat/barley/mustard) produced significantly greater yield at around 2.2, 2.4 and 1.2 t/ha wheat, barley and mustard respectively than other treatments. The effect of location had significant difference on the crops yield. At Amtali, wheat, barley and mustard were found significantly greater yield than Dacope coastal regions. The highest salinity of field soil water (EC_w) and osmotic potential were occurred in mid to end of the February 2019 in all treatments in the soil profiles (0-60 cm). The exact soil salinity (EC_e) varied from around 2 to 13 dS/m at Tildanga and 2 to 7 dS/m at Amtali. On average, the osmotic potential was found -200 to -700 kPa at Amtali and -200 to -1300 kPa from December 2018 to March 2019 and highest osmotic potential observed in February 2019 in both locations. Soil water contents substantially decreased in upper soil layers (0-15 cm) at mid February which affected the crop growth stages. The changes in soil pH occurred 5.5

to 6.5 at Amtali and 6.5 to 8.5 at Dacope. The water salinity of the pond, canal and river ranged from around 1.5, 2 and 5 dS/m (November 2018) to 3.5, 4 and 20 dS/m (April 2019). The irrigation water (low saline) was not available to the pond/canal from mid-February to March during the crop growing season which hampered to the crop production. However, the use of FW (low sanity of: ≤2 dS/m) at early growth stages and SW(2 ≥ salinity ≤ 4 dS/m) at later growth stages of wheat, barley and mustard could be an alternative optioned for intensifying cropping system in the coastal saline zones of Bangladesh.

Multi-step ahead prediction of groundwater level fluctuations using coupled wavelet transform and long short-term memory networks

Groundwater level prediction is important for sustainable usage of scarce groundwater reserves of an aquifer to ensure the development of a meaningful groundwater abstraction management strategy. This study evaluated the prediction accuracy and estimation capability of a deep learning algorithm, Long-Short Term Memory (LSTM) network, for multi-step forward forecast of groundwater levels at two observation wells in an aquifer system of the GazipurSadarUpazilla, Bangladesh. Model independent partial autocorrelation functions-based feature selection approach was used to recognize appropriate input variables for the prediction models. Root Mean Squared Error (RMSE) criterion was used to calculate the training and test performance of the LSTM models to select the appropriate numbers of hidden layers and hidden neurons within each hidden layer. The prediction accuracy of LSTM network was evaluated using five statistical performance evaluation indices: RMSE, Scatter Index, Maximum Absolute Error, Median Absolute Deviation, and a-20 index. Results revealed that the developed LSTM models were capable of predicting one-, two-, and three-week ahead groundwater levels at the observation wells GT3330001 and GT3330002. In general, the prediction performances of the LSTM models at GT3330001 were better than those at GT3330002. The overall results indicate that the proposed LSTM models could be successfully employed to predict multi-step ahead groundwater levels using previous lagged groundwater levels as inputs. For improving prediction accuracy, wavelet transform based data pre-processing may be adopted.

Monitoring of ground water level at different BARI stations

This study was conducted at the research fields of Irrigation and water Management Division (IWM) and RARS, Rahmatpur, Barisasl of Bangladesh Agricultural Research Institute (BARI during 2019-2020. Two observation wells were installed at these two locations for regular monitoring of groundwater level fluctuations. In IWM Division research field, a boring depth of 210 ft. with a strainer length 20 ft. was found sufficient for the purpose of groundwater level monitoring. At RARS, Rahmatpur, Barisal, the boring depth was 860 ft with a strainer length of 20 ftIt is noted that the boring depth and the strainer length depends on the underlying water bearing strata. The installation of observation wells at other stations is ongoing. The monitoring of groundwater level fluctuations in the installed observation well at IWM Division and RARS, Eahmatpr, Barisal has been continuing.

Project: Groundwater resources management for sustainable crop production in northwest hydrological region of Bangladesh (BARI component)

A coordinated project entitled "Groundwater resources management for sustainable crop production in northwest hydrological region of Bangladesh" has been implementing by the different NARS institutes like BARI, BRRI and BINA with BARC as coordinate component with a view to sustainable management of groundwater resources of northwest region through optimizing water demand and supply. Field work was initiated with a base line survey in two study areas: Rajshahi and Joypurhat. For collecting baseline information from the project area, a structured questionnaire was developed and 25 farmers from each specified location were interviewed. The existing farming system, groundwater utilization, pricing system and problems in irrigation scheme, etc. were assessed through the survey work. The specified selected locations were Godagari and Tanoreupazila of Rajshahi and Joypurhatsadar and Kalaiupazila of Joypurhat district. Based on the survey results, a few location specific promising cropping patterns based field trials with rice and non-rice crops were conducted with adoption of water saving irrigation technologies in respect of the project aim. Selection of site and farmers has been completed and as part of the cropping pattern based experiment, a number of field experiments with T.Aman rice, potato, mustard, wheat, boro have already been conducted in the selected locations. Meanwhile long-term (1980-2018) historical groundwater level data has been collected and prediction model has been developed by using discrete Space-state modeling approach for future forecasting of groundwater level. It is perceived that groundwater level declination in Rajshahi will be more than double (from 17.87 m in 2018 to 37.62 m in 2040) at all the three observation wells for the next 22 years if the present rate of abstraction continues. Groundwater abstraction pattern due to irrigation, domestic and municipal uses has been assessed and it is apparent that total abstraction will increase by 33-35% in Joypurhat area and by 40-45% in Rajshahi area in the next 20 years. So, appropriate measures should be taken to ensure judicious use of water in all sectors especially in agriculture to protect the groundwater resources from being further depleted. The groundwater quality in the study areas has been evaluated for agricultural use. The water quality indices such as SAR, SSP, RSC, KR and WQI were calculated to find out its suitability for irrigation. In respect of all evaluating criteria, groundwater of the study area was found suitable and can safely be used for irrigation purpose. The increased and decreased recharge scenarios were computed using the existing groundwater pumping values in the year 2018. The three recharge scenarios considered was: (i) actual recharge, (ii) 90% of the actual recharge, and (iii) 110% of the actual recharge. The aquifer processes were simulated using a calibrated 3D finite difference based numerical simulation code MODFLOW. The results revealed that the computed groundwater heads at the three observation wells varied noticeably as a result of the changes in the recharge scenarios.

Irrigation effect on cowpea production in Chattogram region

The study was conducted at the research field of Regional Agricultural Research Station, Hathazari, Chattogram during the rabi season of 2018-19 and 2019-20 to identify the critical stages of irrigation and optimize irrigation in cowpea production. Five treatments were applied: T_1 (rain-fed i.e. local practice), T_2(irrigation at 3 weeks interval), T_3 (irrigation at flowering stage), T_4 (irrigation at pod formation stage), T_5 (irrigation at flowering and pod formation stages). The highest yield (2.2 ton/ha and 2.3 ton/ha in2018-19 and 2019-20 respectively) and highest water stress coefficient (K_s= 1 to 0.6) were found at higher frequency irrigation (T_2). The maximum irrigation (182mm and 194mm) was applied at T_2. In rain-fed condition (T_1), cowpea yield was lowest (1.2 ton/ha). The sustainability of cowpea in low water stress co-efficient (up to 0.05) indicated that field crop was drought tolerant. Irrigation at pod formation stage yield was higher than flowering stage in case of only one irrigation facilities. The pod formation stage was more sensitive to deficit irrigation than flowering stage. Based on the economic analysis, irrigation at three weeks interval was more beneficial (BCR=1.45). Irrigation At flowering and pod formation stage (T_5), the water productivity (1.2 Kg/m3) was higher.

Dissemination of water saving technologies for non-rice crops in saline prone areas of Bangladesh

The experiment was conducted at three upazila under three districts of the southern saline prone areas of Bangladesh. Two water saving irrigation technologies (AFI and drip irrigation) were compared with the traditional farmer practice. Alternet furrow irrigation (AFI) was used for maize and sunflower cultivation and drip irrigation system was used for tomato and watermelon cultivation. Solar power was also used for mitigating the pumping cost in drip irrigation system. The plant population, plant height, cob length, number of seeds per cob, 100 seed weight and yield of maize were found highest (7.50, 255.45 cm , 19.95 cm, 474.30, 25.63 gm and 9.01 t/ha) at treatment T_1 compared with farmer practice (T_2). Also the plant population, plant height, head diameter, number of seeds per head, 1000 seed weight and yield of sunflower were found comparatively high (7.00, 143.57 cm , 59.47 cm, 464.67, 88 gm and 1.99 t/ha) at treatment T_1. Statistically significant yield difference was observed among the treatments (T_1 and T_2) for watermelon and tomato cultivation under solar powered drip irrigation system. Alternet furrow irrigation and drip irrigation treatments gave highest BCR for all crops. The farmers were benefited and interested to use these water saving technologies.

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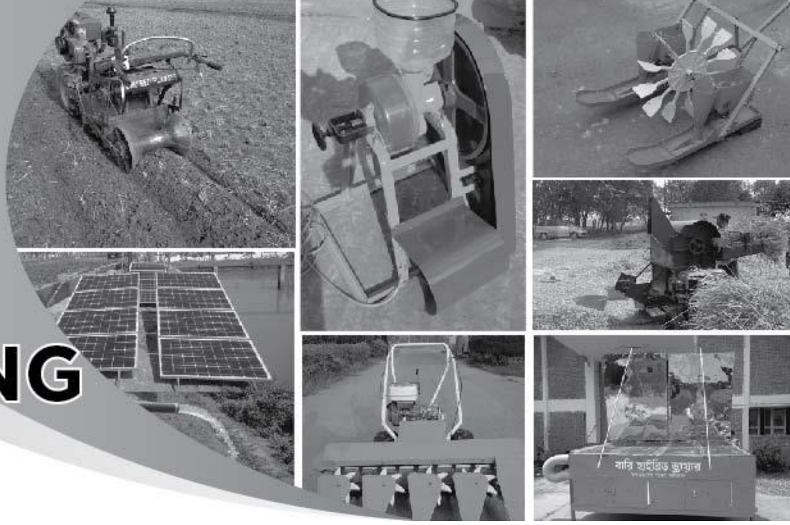


Evaluation and improvement of four-wheel tractor operated zero-till drill for cereal crops

Conservation agriculture (CA) based tillage technology permits direct seeding in untilled soil with moderate level of crop residues. Power tiller is the common farm machine in Bangladesh agriculture but recent days four wheel (4W) tractors are being introduced in farming works along with transportation. Sowing is one of the key factors that influences the success of any crop establishment and productivity. Maximum crop production and seeding operation are needed to complete within the recommended period avoiding slowness, costly operation and decreasing turnaround time. This research work has been undertaken to evaluate the performance of 4W tractor operated zero-till drill and improvement of the seeder for completing seeding operation in a single pass. Five zero-till drills were imported from India. One of them was send to OFRD, Rajshahi for evaluation of field performance with maize (NK40) and wheat (BARI Gom-30) at Godagari and Pobaupazilla of Rajshahi district. The zero-till drill was operated with 4W tractor with 2.05 to 2.40 km h^{-1} forward speed. Effective field capacity and efficiency of zero-till drill varied from 0.31 to 0.36 hah^{-1} and81.64 to 84.13 % respectively. The planting depth(4–5 cm) of maize and seeding depth (2-3 cm)of wheat were desirable.The yield of maize in zero-till plot was 6.00 tha^{-1}. The yields of wheat in zero-till plots were found in the range of 4.20 to 4.75 tha^{-1}. The experiment will be conducted in the next year (2020–2021)to verify the performance in more areas and improve if necessary.

Design and development of a power tiller operated vegetable seedling transplanter

Current vegetable seedling transplanting method is manual that means need to make a hole in the soil then put the seedling at the proper depth and finally fill-up the hole. All of these works are laborious, time-consuming and costly. Three-dimensional projection of the transplanter was drowned by Solidworks2016. A power tiller operated vegetable seedling transplanter was designed and fabricated with locally available iron materials at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2018-19. The transplanter consisted of dibbler, dibbler pressing sprocket, chain, press wheel, seat, depth adjusting wheel, etc. The machine can transplant seedling two rows at a time and distance between the rows is adjustable up to 40-100 cm. Seedling spacing was adjusted and irrigation water was supplied at a time. The experiment will be continued in the next year for better field performance.

Improvement and validation of BARI seeder for grain crops under different cropping patterns and soil conditions

Timely tilling and seed sowing are a major challenge in crop production,specially after harvesting of *aman* rice. Improved seeder (reduced, strip- and zero-tillage) required single pass for completion of land preparation and sowing of seeds in line whereas power tiller required 2–3 passes for land preparation. The improved seeder was found suitable for planting different types of crops such as wheat, maize, lentil, mungbean, sunflower, cowpea, etc. During rabi 2019–20, 4.22 ha of wheat, maize, mustard and lentil were planted by the improved seeder in Godagari and 8.04 ha of wheat and lentil were planted in Tanore, Rajshahi. Maize, mungbean and sunflower were planted about 1.32 ha of land in Kalapara and 2.66 ha of maize, mungbean and cowpea were planted in Dumki, Patukhali by the improved seeder. Slightly higher depth of tillage and field capacity were found in soft soil in Patuakhali than hard soil in Rajshahi. So, the field performance of seeder was found satisfactory in both Rajshahi and Patuakhali. There were four treatments (PTOS, strip-tillage, zero-tillage and conventional method) in the field experiments of Rajshahi and Patuakahli. Significantly the highest crop yields were found from reduced tillage (PTOS) than strip-tillage, zero-tillage and conventional methods. PTOS is effective in crop planting method in all project locations. In four project locations, 120 operators and farmers were trained through four practical trainings on operation, repair and maintenance of improved seeder. Awareness of 160 farmers were created through four field days in the project locations. Farmers of Rajshahi liked strip-tillage but in Patuakhali they liked full tillage for planting of crops.

Energy use analysis of CA tillage systems for rice-maize cropping pattern

Sufficient supply of the right amount of energy and its effective and efficient use are necessary for an improved agricultural production. Conservation agriculture (CA) based management could considerably help smallholder farmers and make considerable contributions to food security. System-based evaluation of the CA in respect of energy and economics is important. Therefore, a study was undertaken to assess productivity, quantify energy flow and financial profitability of CA tillage methodsfor Rice-Maize cropping pattern. Treatments were-conventional Tillage (CT) T. Aman-CT Maize, CT Machine transplanted T. Aman-CT Maize, CT T. Aman-Strip-Tillage (ST) Maize, CT T. Aman-Zero -Tillage (ZT) Maize, STMT T. Aman-ST Maize, Strip-till followed by manual transplanting (STMT) T. Aman-ZT Maize, Unpuddled Tillage (UPT) T. Aman-ST Maize, UPT T. Aman-ZT Maize. Crops were cultivated in the cropping pattern during last Rabi season of 2017-18 and 2018-19. Yield of maize and T. aman for different treatments were not significantly varied. Direct energy consumption was accounted for only a small proportion of the total energy consumption during maize cultivation. Indirect energy of maize shared lower amount in CT than ST and ZT. Direct energy of T. aman rice cultivation was the highest in CT and the lower ST and ZT. The highest energy output-input ratio was found for unpuddledT.Aman-ZT maize cropping systems. The highest input cost and return was recorded in CT T. Aman-CT Maize cropping pattern but the highest BCR was found in UnpuddledT.Aman-ST Maize cropping pattern. Thus, the experiment will be continued in the next year for completion of the cycle.

Performance evaluation of power operated seeder in southern region of Bangladesh

Power operated seeder was demonstrated in different locations at farmers' fields of Rajbari, Faridpur, Barishal, Jhalkathi, Patuakhali and at the research farm of Regional Agriculture Research station (RARS), Barishal during 2019–2020. The seeder performed seeding operation utilizing the soil moisture after harvesting Boro rice along with the use of Hi-speed Rotary Tiller (HSRT). It maintained uniform seeding depth, uniform seed distribution and better seed soil contact which transferred soil moisture to seeds quickly for enhance better plant establishment and yield. POS was able to complete seeding and laddering operation in a single pass with an average field capacity of 0.16 ha/h. The yields of Cowpea under POS (1.5 t/ha) and conventional (1.42 t/ha) systems had no significant difference. A similar response was also obtained from Mung bean with 2.83 t/ha and 2.77 t/ha, respectively, for POS and conventional systems. But significantly higher yields of Mustard (1.71 t/ha), Lentil (1.82 t/ha), Wheat (4.11 t/ha), Black Cumming (1.27) and Coriander (1.42 t/ha) were found for POS over conventional method. The POS covered127.67 ha area under different adaptive trials and field demonstrations in seven districts of Bangladesh.

Optimizing the performance of precision seeder for conventional and strip-till sowing of maize

Reduction of production cost and mitigating labour crisis is a major challenge in Bangladesh agriculture. Seeding is one of the most crucial agricultural operations which is still done manually in primitive ways that involves lots of labour and huge cost in line sowing. Mechanical seeders can bring down the cost, labour and time requirements. However, small scale low cost seeders available in

Bangladesh suffer from low accuracy (multiple seeds/hill, missing and seed locking) when maize and other bold seeded crops (requiring sowing seeds one by one) are planted. Further, furrow backfill usually is low (leaving seeds uncovered by soil) and seed furrow compaction is inadequate during strip-till planting. To overcome these limitations in strip-tillage, a prototype precision seeder (PS) was developed at the MFPE Division of BARI, Gazipur in 2018 and improved in 2019. The PS used precision seed meter that has high seed simulation capacity and zero seed blockage. Comparison of performance of the prototype Precision Seeder (PS) with BARI model 2 Seeder (BS) and conventional practice (hand planting) for strip-till planting of hybrid maize (Elite) at the research field of the FMPE Division, BARI, Gazipur. Results indicated that the PS produced 50% more backfill, 67% less uncovered seeds, optimally compacted the seed furrow, and reduced number of multiple seedlings by 184% compared to the BS. After thinning out the multiples, the PS established more plants compared to the BS or control plot. However, all these improvements in backfill providing better seed cover, optimal compaction of seed furrow and reduced multiples did not contribute to differ yields significantly between the seeders. The plots planted by the seeders yielded 11–13% higher compared to hand planting. This result is promising considering the scope of expanding mechanized crop production in winter fallows of southern Bangladesh where the soil retains excessive soil moisture at planting. In order to test suitability of the seeders in varying soil and cropping conditions, wide field testing for conventional and conservation agriculture is suggested.

Design and development of prilled urea applicator for up-land crops

Fertilizer deep placement (FDP) is a proven technology for growing different crops all over the world. FDP is more effective than the traditional method (surface broadcasting) of applying fertilizer across a field. An experiment was executed at the research field of Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Rahmatpur, Barishal during Rabi season (2018-19) to develop prilled urea applicator for increasing fertilizer use efficiency and to increase crop production with saving of fertilizer and environment pollution with three treatments (T_1: Prilled urea broadcasting (Farmers' Practice), T_2: Prilled urea deep placement by applicator and T_3: N, P, K deep placement by applicator). The design of the experiment was randomize complete block (RCBD) with three replications. The variety of potato was BARI Alu-41. The fertilizer use efficiency of urea was more in deep placement treatments than broadcasting. The highest yield was found (34.40 t ha^{-1}) at T_3 treatment followed by T_2 (32.75 t ha^{-1}) and T_1 (27.43 t ha^{-1}). The yield increase percentage was higher in deep placement treatments (T_3: 25.4% and T_2: 19.4%) than broadcasting of urea. The benefit cost ratio (BCR) was greater in T_3 (1.15) and T_2 (1.04) than T_1 (0.77).

Adaptive trial of a battery operated rotarytype low cost weeder

The overall goal of this experiment was to reduce the production cost and drudgery of labor in weeding purpose and use of renewable energy for upland crop production. The main objective of this research is to do adaptive trail of modified weeder at the different locations of Bangladesh through OFRD. The overall goal of the research is to evaluate the performance of a DC motor operated rotary type weeder instead of fossil fuel operated mechanical weeder in upland crop production and reduce the cost of farming as well. The specific objective of this weeder is to remove weeds by using battery power rather than other weeding practices to reduce time, save money and increase work effort of labor. Adverse effects on environment and cost of chemical weeding are making farmers to consider and accept mechanical methods of weed control. Manual weeding is common practices in the farming system of Bangladesh. It is the most widely used weed control method but it is labor intensive. The mechanical weeder is to reduce drudgery and cost which ensure a comfortable posture of the farmer or operator during weeding. The costs associated with mechanical weeding such as operating cost can be lowered; as such mechanical weeding can represent a viable and cost effective option to majority of medium and small scale farmers in developing countries like Bangladesh. According to the last year field test, we have found couple of recommendations which are: incorporate forward speed in wheel, increases the wheel size, earthing up soil to make furrow. This year we are working on these recommendations and want to develop modified version of upland weeder. We will also evaluate the performance of weeder in the different locations of Bangladesh through On Farm Research Division (OFRD). We made fields trial on maize at FMPE Research field of Bangladesh Agricultural Research Institute and On Farm Research Division (OFRD), Kishoregonj. Weeding index of battery operated weeder for maize is 99.52% which is very close to chemical weeding. Again effective field capacity i.e. area coverage of battery operated weeder for maize is 0.04852ha/hr. Plant damage ratio is very limited for maize which is only 0.010%. Cost of weeding by battery operated weeder is almost half compare to BARI weeder and just about one third compare to manual weeding but equivalent to chemical weeding. Significant difference is found in yield among these four methods, and height yield is found in battery operated weeder due to more nitrogen infestation in soil. Adaptive trail in farmers' field will continue next year.

Design and development of an automatic irrigation device

Agriculture in Bangladesh has made remarkable progress in terms of production and diversification towards high value crops over time. Irrigation is a crucial part in crop production. Automation in irrigation systems is an emerging need to solve multiple issues related to conservation of water resources and sustainable agriculture. To address this matter an experiment was undertaken at FMPE Division, BARI, Joydebpur, Gazipur during 2017-18 to develop an automatic irrigation device in order to enable the farmers to apply exact amount of water in the right time with minimum involvement of human labour. Initially a prototype was developed during 2018-19 which was an integrated device comprised of the control unit and sensor unit housed in the same box. It was made to run and stop a pump in order to control flow of irrigation water. During 2019-20 a modified prototype was developed in which sensors units were separated from the control unit; wireless modules and solenoid valve were attached to the system to supply water from a reservoir or tank instead of controlling the water pump. This prototype can be controlled by smartphone and personal computer even without internet connection. The system was run in the laboratory. Sensor readings were calibrated with respect to actual soil moisture content. Discharge rate from the solenoid valve was measured which was not satisfactory. After some modifications this device will be set up in the field in the next Rabi season to evaluate its field performance.

Design and fabrication of petrol engine operated boom sprayer for field crops

Sprayer is an important equipment to ensure proper application of pesticides as well as to save the crops from damage due to pest infestation. It contributes remarkably in pest management and substantially increases food production saving huge crops worth. In Bangladesh, most of the farmers are small and marginal land holder and spraying operation in their field is done by different types of single nozzle manually operated sprayer which consumes more time, energy and drudgery. Therefore, a petrol engine operated boom sprayer was designed and fabricated at the workshop of Regional Agricultural Research Station, Jashore during 2019-20. The machine was fabricated with locally available materials and spare parts and tested. The sprayer consists of a light weight power unit (4 hp petrol engine) and two spraying unit (made by knap sack spray unit). It consists of two narrow rubber wheels in front side and one in rear side which are powered from engine through belt, pulley, chains and sprockets. The ground clearance of the machine is 900 mm. A third wheel was provided at the rear which acts as not only a support but also as power wheel. The spray units consists of two tanks of 16 liter, reciprocating type spray pump ,two booms of 3 nozzles in every booms (totally 6 nozzles) and mounting frame to adjust boom height from 350 mm to 900 mm to suit different crops as per plants height .The nozzle spacing was set at 500 mm in the boom. For lab test, two lines 20 m apart were marked on the floor and the machine was dry run for 20 m. The forward speed was 3 km/h. Effective width of coverage, theoretical field capacity, effective field capacity and efficiency were 2.93 m, 0.91 ha/h, 0.53 ha/h and 57.72 % respectively. Due to transfer of PI from Jashore to Gazipur and COVID-19 situation, detail evaluation, field test and economic analysis could not be completed this year. Thus the experiment will be continued in the next year.

Adoption of PTOS and up-land weeder on pulse cultivation in southern region of Bangladesh

A power operated multi-row weeder was fabricated at Regional Agriculture Research Station, Rahmatpur, Barishal in 2019-20 for weedingcowpea .The Weeder along with PTOS was compared with other available weeders and conventional method of seeding namely BARI drylandweeder, conventional weeding using *niri* or spade for cowpea to find the performance of power weeder and PTOS during 2019-20. The power operated multi-row weeder obtained the higher field capacity (0.156 hah^{-1}) was found. Most at was the efficient tool for weeding, particularly in view of time taken in operation followed by BARI dryland weeder (0.023 hah^{-1}), and Niri or spade (0.003 hah^{-1}).There was no significant difference of yield in case of PTOS seeding and conventional seeding. In spite of higher percentage plant damage (4%) was done by the power weeder but it has not significant effect on crop establishment. Improvement is required for convenient operation of the weeder.The highest (1.56 t ha^{-1}) grain yield was obtained when weeding was done by BARI Upland Weeder and seeding with PTOS. The lowest (1.40 t ha^{-1}) yield was found when weeding was done by Power Weeder and seeding by PTOS.

Development and adoption of two-wheel tractor operated potato harvester

A two-wheel tractor driven potato harvester was developed and improved with locally available materials at Farm Machinery and Postharvest Process Engineering Division of BARI, Gazipur to facilitate small farmers to harvest their potatoes at low cost. The harvester was a semi-automatic digging machine consisting of digging blade, conveyer flat chain, guide plate and power transmission arrangement. The dimension of the potato planter was 900 mm × 850 mm × 950 mm. Field performance of potato harvester was evaluated at Regional Agricultural Research Station, Jashore, Tuber Crop Research Substation, Bogura, ten farmers' fields in Bogura and Jashore and Breeder Seed Production Station, Panchagarh during the Rabi season of 2018-19. Field performance of potato harvester was better than manual method at different locations of Bogura and Jashore. The highest field capacity was obtained at Gazipur (0.12 ha h^{-1}) followed by at Bogura (0.109 hah^{-1}) and Jashore (0.107 ha h^{-1}). Potato harvester required labourers21 per ha compared of 60 labourers per ha in traditional manual method. Total cost of potato harvesting by the potato harvester was Tk. 12023 per ha but manually harvesting method the cost was Tk. 29,600 per ha. Lifted tuber was found 94% for potato harvester whereas for manual method it was 66%. Damage tuber was 2% higher in manual harvesting method than the mechanical harvesting method. The experiment will be conducted next year.

Design and development of diesel engine operated onion harvester

The present research work has been carried out to bring out the reliable solution for harvesting of onion crop. The harvesting of onion crop is the labor intensive operation. The attempt has been made to design the harvester for the low power capacity especially 4 hp air cooled diesel engine. The size of the harvester has been decided with respect to the agro technical features of the crop, it covers two row in one pass. The working width of the harvester has been worked out to be 30 cm. The depth of operation for the onion crop has been decided up to 5cm. The width and depth ratio was come to 12:1 which is fit to the design. The estimated capacity of the harvester in respect of the working in the soil has worked out to be 1 tones/hr. accordingly the materials for the fabrication has been decided as per the BIS standard. The drawbar power requirement for effective working of the harvester has been optimize from the travel speed, the total soil load and the discharge of soil mass and the capacity of soil to be work. The estimated power requirement for the onion harvester is comes to 3-4 hp. The total weight of the machine was calculated comes to be 35 kg. The cost of the onion harvester with engine was worked out to be 25000tk. Design and fabrication is done and field trial is conducted in Irrigation and water Management (IWM) and Seed Technology division research field. Field capacity and field efficiency of onion harvesting BARI air cooled diesel engine operated onion harvester were 0.080 ha/h, 88.89% and 0.075 ha/h, 83.33% respectively in IWM field and Seed Technology field as well. Onion damage ratio was very low which less than 0.5% for BARI air cooled diesel engine operated onion harvester. Width of harvesting was 300 mm and depth of harvesting was 49.3 mm for BARI air cooled diesel engine operated onion harvester. One-third time was required for harvesting by BARI air cooled diesel engine operated onion harvester compare to traditional practices. Due to COVID-19 situation, field trial in farmers' field cannot be done this year but it will be done in next year.

Development of tractor mounted maize harvester

Maize harvesting is one of the most important field operations of maize production. Manual maize cob harvesting method practiced in Bangladesh is a very laborious, time consuming and costly operation. As the accelerating development of maize industry, mechanized maize harvesting is widely accepted and used by farmers in the world. According to the harvesting methods, maize harvesters could be classified into two types, one is maize-for-grain harvesters, including pickers and grain harvesters, the other is whole plant harvesters, including forage harvesters and combined grain-stover harvesters. Here 3D CAD model of a whole maize plant harvester was designed using SolidWorks®. It consists of a divider, lugs, grippers, cob separators, cob and stover collector, power transmission system, etc. The harvester will be fabricated and tested for maize in the next year.

Evaluation and improvement of self-propelled power thresher

Power threshers have been proven as one of the most successful agricultural machine in Bangladesh. Power threshers are available in different sizes and models. This study was undertaken to evaluate large self-propelled power threshers developed by the manufacturers in different parts of Bangladesh and identify any problems related to the machines. It was conducted in Chalan Beel area in Pabna and Sirajganj districts during December 2019. A questionnaire survey was conducted among 7 owners of self-propelled power threshers. The study revealed that break-even use of the threshers was 437 ton of threshed rice that corresponds to about 365 hours of their operations. Benefit-cost ratio (BCR) was calculated as 1.97, which was economically acceptable. From observations it was found that the threshers had some problems in power transmission systems of the transportation units, materials of the concave and design of the feeding chute. There were also risks of injury due to lack of adequate safety features. This study will be continued in the coming years to get full scenario of technical and economic aspects of the threshers and identify some areas of possible improvements.

Design and development of onion and garlic detopper

Onion and garlic are important spice crops in Bangladesh. After harvesting onion or garlic, the edible bulb portion is separated from the inedible stem by cutting or detopping (leaving only 20–40 mm stem with the bulb). This cutting is usually done manually, one by one, mostly using a sharp kitchen knife (*Boti*) which is laborious, time consuming and costly. Two models (Model 1 and Model 2) of power operated detopper was designed and fabricated at the Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute during 2019–20. The detoppers were made with locally available materials and operated with a 0.37 kW electric motor. Important parts of the machine were feeding table, conveyor, cutter and outlet. The detopper was developed and tested in laboratory during 2019-20. The capacity of the detopper of model 1 and model 2 were 29.35 and 65.10 kgh-1, respectively. The capacity of Model 1 and Model 2 were found as 53% and 77% higher than the manual detopping, respectively. However, for increasing the capacity of those machines, the feeding system along with other technical mechanism will be changed or improved in the next year.

Development of a power operated sunflower thresher

A study was conducted for solving the problem faced by the farmers in separating the seeds from the sunflower. Farmers use the manual methods due to unavailability of suitable machinery for sunflower threshing. During manual sunflower production, the most time and labor consuming operation is the threshing of sunflower by beating the sunflower heads with a stick, rubbing wear heads against a rough metal surface or power tiller treading machine. The aim of the experiment is to design and develop a power operated machine which will separate the seeds from the sunflower. An orthographic projection was drawn with SolidWorks 2016 Software. The sunflower seed thresher was then fabricated at FMPE Divisional workshop with available local materials during 2017–18. The developed sunflower thresher was modified during 2018-19. The space between the pressing rollers (38mm to 35mm) were reduced. The cover of the machine was redesigned to primary hopper. A threshing fan was incorporated in the improved version to separate the dust part from the grains. The capacity of the power operated sunflower thresher was 115% and 197% higher compared with pedal thresher and manual threshing respectively. Capacity of the thresher varied with moisture content. Capacity of the thresher was varied from 89 to 125 kgh^{-1} within 31 to 62% moisture content (wwb). Effect of variety and moisture content on threshing should be analyzed. Economic analysis should be done. Farmers feedback should be collected and incorporated accordingly. The experiment will be continued in the next year.

Development and operation of a groundnut harvesting machine

Groundnut harvesting is a time consuming and labour intensive operation during peak seasons. Harvesting operation by power operated groundnut harvesting machine is ongoing agricultural mechanization expectation to harvest groundnut in right time and save harvesting time. This study of a power tiller mounted groundnut harvesting machine was developed by the modification of BARI potato planter with the available locally collected materials in Mahbub engineering workshop during the crop season 2019-20 for harvesting of groundnut for small and medium scale farmers during the peak time. The modification was done by the increasing length of the conveyer belt and power transmission system. The harvesting machine consisting of digging blade, conveyer flat chain, guide plate and power transmission system. The dimension of the groundnut harvester was 705 x 670 x 510 mm. The field test experiment will be conducted next year to characterization of harvesting parameters.

Development and performance evaluation of a cashew nut sheller

Cashew (Anacardium occidentale L.) is one of the high value crops in Bangladesh. It is cultivated in limited areas of Chittagong and Chittagong hill tracts. The cashew fruit is unusual in comparison with other tree nuts since the nut is outside the fruit. Removal of cashew kernel from its shell is a labour intensive operation. Therefore, manual and semi auto cashew nut shellers were introduced by FMPE Division, BARI for easily removal of kernels. Raw cashew nut was boiled in water at 100 °C for 30 minutes. It was dried using BARI solar dryer at 60 °C for 6 hours of drying time. The shellers were tested with three sizes (small, medium and large) of boiled and dried cashew nut.Numbers of raw cashew nuts, number of unshelled cashew nuts, whole kernel, split/broken kernel and half kernel etc were recorded. Shelling rates and shelling efficiencies of the manual sheller for all sizes of nuts had almost the same whereas whole kernel recovery was varied from 44.52 to 64.00%. The highest shelling capacity, shelling efficiency and highest whole kernel recovery of motor operated semi auto sheller were found to be 6.26 kgh^{-1}, 87% and 61.46%, respectively. The highest whole kernel recovery of both the manual and semi auto sheller was observed in large size nuts. But, higher whole kernel recovery was found in manual sheller than that of semi auto sheller. Shelling capacity of semi auto sheller was five times compared to manual sheller. On the other hand, shelling efficiency of manual sheller was higher than that of semi auto sheller. The shelling rate of manual sheller was double compare to last year finding (0.50kgh^{-1}).The performances of both the shellers would be increased using different moisture contents and different sizes of cashew nuts in text year.

Development of soymilk making machinery

Soybean provides a cheaper and high protein rich alternative substitute to animal protein. A study was conducted for making soymilk from soybean. In Bangladesh, uses of soybean for these food items are restricted due to unavailability of suitable machines. The design of the soya milk production and pasteurization plant would assist in increasing soybean in human consumption. The experiment was conducted to develop soymilk making machinery to increase consumption of soybean as human foods during 2018-19. A blender and a pasteurizing unit was designed and developed for making soymilk during 2018-19. The performance of blender and pasteurizing unit were done and a soya poneer press was developed during 2019-20. A blender and a pasteurizing unit was designed and developed for making soymilk. Capacity of the blender and pasteurizing unit was 2 liters and 6 liters, respectively. The operational time 40 seconds was selected with 76.78% blending efficiency to prepare soymilk for each batch. Time for heating the interlayer water upto 100 ˚C was 38 to 40 minutes. Time for reaching milk temperature upto 100 ˚C was 05 minutes only. The soymilk was prepared with 20 minutes pasteurizing. The soya poneer was prepared and sensory evaluation was done. The panelists showed their satisfaction on soya poneer. The experiment will be continuing in the next year to improve the machine performance and finalize the soymilk making parameters.

Design and development of a small scale millet dehuller

Millets are considered as minor cereals of Bangladesh and commonly grown in marginal land areas (saline coastal areas and chars). Its production contributes to the food security, nutrition and income security of the resource poor farmers in these marginal areas. Dehulling of the millet is traditionally done manually using mortar and pestle. This traditional dehulling is a labour and cost intensive operation and involves human drudgeries. In order to reduce the cost and drudgeries, a low cost millet dehuller was fabricated and tested at the FMPE Division, BARI, Gazipur during 2018-19. It is an impeller type centrifugal dehuller powered by an electric motor (3 Φ, 750 W, 1400 rpm). The batch type dehuller was tested during 2019-20 with millet grains containing varying moisture contents of 12, 14 and 16% (wwb). The feed rate and dehulling time were maintained at 167 g/batch and 90 s, respectively as per recommendation of previous year’s results. Results showed that the moisture content has a significant effect (linear) on the performance of the dehuller. For example, the dehulling efficiency fell slightly by about 1% due to the increase of grain moisture content by 4%. Whilst, the head grain recovery and total milling recovery fell by about 14% and 8%, respectively for the same increase in grain moisture content. The change in moisture content resulted in increased broken grains (11.2–24.0%) that reduced head grain recovery. Analysis of husks data revealed that a considerable percentage (16–22%) of grains (mostly milled rice) were lost with the husks after the cleaning process (by blowing fan). The cleaning loss sharply increased over 14% grain moisture content. Therefore, millets grains should be thoroughly dried to a low moisture content below 12% in order to have high dehulling performance. Review of the blower speed and/or design to reduce the cleaning loss and on-farm and economic performances of the dehuller for millets and other food grains are suggested.

Design and development of a jackfruit peeler

Bangladesh produces huge amounts of jackfruit. It is a seasonal fruit and its price become low during the peak season. The unripe jackfruits could be used in vegetable curries and pickles. If we can increase consumption of immature jackfruit, mature fruit loss could be reduced. Main problem of such consumption was difficulty in peeling. The main aim of the research was to develop a jackfruit peeler and to solve the problems. A power operated jackfruit peeler was designed and fabricated in the workshop of FMP Engineering Division of BARI Gazipur during 2017-18. Initial model was tested and showed satisfactory performance but that was made of mild steel which may cause adulteration in food item. Therefore, it was improved and fabricated with stainless steel during 2019-20. The peeler is an electric motor (0.37kW) operated machine where power transmitted to the cutting blades and jackfruit was rotated. Mechanical peeling was done with two steps: in the first step, a minimum thickness was peeled. Then, optimum peeling was done in second step. Capacity of the mechanical peeling was 3.9 and 6 times higher than the manual peeling for unripe jackfruit and sweet guard, respectively. Four BARI developed peelers were purchased by the department of agricultural marketing (DAM) to process green jackfruit. This machine could be used by others for commercial use.

Development of a cream separator

The current cream separating method is manual that means need to cook the milk then keep it for cooling and fat will compose in the upper surface to collect it. All of these works are laborious, time-consuming, and costly. Three-dimensional projection of the cream separator was drowned by SolidWorks®. A motor and leg operated cream separator was designed and fabricated with locally available iron materials at Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur during 2019-20. The machine was made of a motor, SS rod, SS sheet, and SS bar, etc. It consists of different parts like feeding bucket, uniform distributor, cream collecting outlet, skimmed milk collecting outlet, rotating disc, power transmission system, etc. The machine required 7000–8000 rpm to separate the cream from milk. The average feeding capacity of the machine around 150 kg h^{-1}. The ghee recovered from total milk around 2.45% and machine operation has no significant effect on protein change in milk. The separation efficiency of the machine was 86%, while the fat down from 3.30% to 0.47%. The benefit-cost ratio of the cream separator was found to be 1.62 and the pay-back period was 0.85 years. Its women friendly machine anyone can operate does not require any high technical knowledge. Therefore, the machine is economically profitable for custom hire businesses or small milk processing industries.

Integration of postharvest technologies and best practices in the value chains of fruits and vegetables

The study was conducted at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur and Shibpur, Charghat, Rajshahi district during 2019-2020. The variety of Rangin Sagar banana and packaging of carton of 20 kg, plastic crate of 15 kg and wooden box of 20 were used for conducting the experiment. Firmness, brix, angularity and hue angle of harvested matured banana were found to be 74.46-81.35 N, 3.4°, 45.75-52.67° and 117.12-119.99° respectively. Two hundred twenty bunches of banana from orchard at Shibpur, Charghat and 50 bunches of banana (local Rangin Sagar) from Banesshar assemble market under Rajshahi district were purchased on 28 October 2019. The banana hands were packed in wooden box, plastic crate, and CFB carton with wrapping of newspaper, cling paper and without wrapping. One hundred hands and same quantity of bunches were loaded in track. They were transported from Rajshahi to Gazipur on 28 October 2019. Traveling distance and traveling duration was recorded to be 220 km and 5 hours (3.00pm to 8.00 am). The inside temperature of packages loaded with hands and in the heap of bunches increased with the traveling period. Rate of ripening process of banana was accelerated during the traveling period. There was no significant difference among the treatments in respect hue angle, chroma and brightness. In respect packaging systems, the highest weight losses were found in without wrapping package (0.20%) whilst the lowest was in wrapping of cling paper (0.03%) for all packages. CFB carton showed the negligible weight loss. The highest bruising losses in market hands were found to be 59% due to surface rupture, injury, crack and damage. Market bunch and hands showed higher bruising than those of orchard. There was no significant difference between orchard bunch and market hands whilst had significant difference between orchard bunch and hands at 5% level. The better quality of orchard hand and bunch was observed. Market price of ripe banana was low due to bruising of banana. There was no bruising occurred in wrapping with newspaper and cling paper of all packages. There were little losses occurred in without wrapping packages those had significant difference. The banana traders would be benefited if they buy banana bunches from orchard, packing and loading in neighboring the orchard and using plastic crate for local market and CFB carton for supper market. Economic analysis will be incorporated in the next year.

Development of a mobile spice grinding machine for small entrepreneur

The major thrust of this experiment is the development of an improved mobile spice grinding machine which will be mostly used in cottage industry for the grinding spices and grains of any form. Adulteration in powder spices is a major problem now a days. Most of the people do not trust packet powder spices. But people in urban areas are facing huge problems for grinding spices. For this circumstances, mobile spice grinding will be a perfect way to provide pure spice to urban people and it also flourish the cottage industry and increase employment. The construction of the work is simple and it employs the maximum utilization of locally sourced materials, which are readily available hence, a reduction in its total cost. This year only design through SOLIDWORK is done. Due to COVID-19 pandemic situation, fabrication is not started yet.

Upscaling and fine tuning of coffee postharvest processing machinery

The coffee growers of Hill Tracts process the green coffee at home and the quality is very low. They consume it for their own purpose but for commercial purpose the quality must be maintained. Like other processing steps, coffee pulping and dehulling are also a machine involve process because it is a very labor intensive job. The coffee growers of Bangladesh usually pulp by hand in pestle and mortar. This practice is very costly, time consuming and laborious and produce low quality products. BARI has developed small scale coffee pulper and dehuller. The performance of the pulper was evaluated with cherry fresh harvested (FHC_0) and cherry harvested 3 weeks ago (CHW_3) of the Arabica variety collected from Hill Agricultural Research Station, Khagrachari during 14-16 February 2020. The colour of FHC_0 was orange-red and W_3HC was red colour. Orange –red colour of cherry showed better for processing of coffee. The higher whole parchment recovery (80%) was found in FHC_0 than that of CHW_3 (76%) whereas pulping rate was 105 kg/h and capacity was 157 kg/h for cherry. Cherry and parchment were dried using BARI solar dryer at 60 °C. The moisture contents of fresh harvested cherry, cherry harvested 3 weeks ago, parchment of harvested 3 week ago and fresh harvested parchment were found to be 12.28% (wb), 12.99% (wb), 14.94% (wb) and 34.40% (wb) respectively. On the other hand, hue angle (h°) of coffee at different processes stage was found to be 16.71° (orange –red) in fresh cherry, 71.68° (light yellow) in wet parchment, 72.54° (light yellow) in dried parchment, and 75.41° (light yellow) in green bean. The performance of dehuller was evaluated with fresh dried cherry(FDC_0), dried parchment (from fresh cherry), dried cherry harvested 3 week ago(W_3DC), dried parchment (harvested 3 week ago) (W_3DPdr) and fresh dried parchment (FDP_0dr) at FMPE Division, BARI, Gazipur during 27-28 April 2020 and 21-23 June 2020.The capacity of the dehuller for FDC_0 (51 kg/h) was double than that of W_3DC ($24kgh^{-1}$). The higher capacity was found in FDP_0dr than that of FDP_{0sd} due to lower moisture content of FDP_{0dr} whereas same capacities in both the W_3DPdr and $DPsdW_3$ though moisture contents of them were varied. On the other hand, the highest and the lowest damage of bean were found to be 27% and 7% in FDP_{0dr} and W_3DPsd respectively. The highest and the lowest of dehulled beans were found to be 75% and 56% in FDP_{0dr} and W_3DPsd respectively. The highest capacity of the dehuller and dehulled bean were found to be 142 kgh^{-1} and 78% in W_3DP followed by $FHDP_{0dr}$ and $FHDP_{0sd}$. The study will be continued for better findings and economic analysis.

Improvement of chilli seed separator

A power operated chilli seed separator was developed at the workshop of the Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the period of 2018-2019. Feeding capacity for dry chilli was 700 g and throughput capacity was 10.94 kgh^{-1}. The main problem of the machine was, the machine needed to be stopped after four minutes to take the flakes out of cylinder in between seed separation. To solve the problem and to increase capacity, the machine was redesigned and fabricated during 2019-20. The machine has a provision for continuous feeding and separate ways for outflow of seeds and chilli flakes. The separator was tested with dry chilli at 9-12.4% varying moisture content. The throughput capacity was found 30.92 kgh^{-1}, seed separation capacity of the separator was 8.1 kgh^{-1} and seed separating efficiency was 73.83%. No seed injury was observed as well as no significant effect was found in germination or seedling emergence. The experiment will be continued to the next year for improvement of its performance.

Design and development of a tomato seed separator cum pulper

Tomato is an important vegetables grown round the year in Bangladesh. Tomato seeds are very sensitive and costly. Tomato seeds are separated manually all over the country. There is no effective mechanical device of separating tomato seeds from fruits. Conventional method is very slow and highly labor intensive. Moreover, the fruit portion of the tomato is totally wasted in conventional method. The mechanical method is a better solution to this problem. Therefore, a power operated tomato seed separator was designed and fabricated at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute during 2019-2020. The seed separation capacity was found to be 2.4 kgh^{-1}, friction loss was 8.31%, throughput capacity was 47.31 kgh^{-1} and seed separation efficiency was 94.93%. Extracting capacity of machine was 8 times higher than that of manual extraction method. It saved time 8.3 times than that of manual method. The pulping capacity, cylinder loss and cleaning efficiency were found to be 45.51 kgh^{-1}, 8.31% and 63.62% respectively. No seed injury was observed as well as no significant effect was found in germination or seedling emergence. The experiment will be continued to the next year for improvement of its performance.

Improvement of coconut tree climber

Most of the coconut growers harvest coconut manually in Bangladesh. Traditional manual techniques for harvesting of coconut are used in the different locations of Bangladesh. Traditional method of coconut harvesting is climbing on a tree directly by hands and feet. Farm Machinery and Postharvest Process Engineering(FMPE) Division of Bangladesh Agricultural Research Institute (BARI) has already developed a manual coconut tree climber that was standing type. So, a sitting type coconut tree climber was fabricated at the workshop in FMPE Division of BARI. During testing operation the height of the trees was taken from 6.9 m to 9.7 m. The highest speed of the sitting type climber during climbing up a tree was 10.54 m min^{-1} and the highest speed of climber during climbing down from a tree was 7.46 m min^{-1} when the height of the tree was 9.7 m. The average speed of the climber during climbing up was 8.19 m min^{-1} whereas it was 6.81 m min^{-1} during climbing down from the tree. The operator's blood pressure datum was varied from 10–20 mmHg of systolic and diastolic pressure. At the beginning it is time consuming but with continuous use and practice it will reduce the time required for the climbing. Though there are some problems in coconut climbing machine but it will be useful for both the residential growers and commercial cultivators. The price of the machine is calculated about Tk. 5000.

Performance evaluation of flat bed dryer for maize drying

Drying is the removal of moisture by the application of heat and drying is practiced to maintain the quality of grains during storage to prevent the growth of bacteria and fungi and the development of insects and mites. The safe moisture content for cereal grain is usually 12 to 14% moisture on a wet basis. Seed moisture content is one of the factors which determine whether or not seed can be stored safely without loss of germination and vigor. The maize grains were dried in flat dryer in Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur during 2019-20. Maize grains were dried in the flat dryer at 60, 50 and 40°C to find out the drying temperature and drying time. The lowest time required to dry from an initial moisture content of 30% (wb) to final moisture of 14% (wb) was 9 hours at 60°C when air velocity was 1.5 ms^{-1}. Drying characteristics for different loading capacity, air velocity and temperature will be determined and economic analysis will be done in the next year.

Development of a small scale barley thresher

Barley is becoming an important health food (for diabetics) and a functional food product to a large portion of people because of the recognized benefit in terms of its higher beta-glucans, zinc and iron content. It can be profitably grown in the coastal fallows of Bangladesh where soil salinity and water-stress prohibit growing most other crops during the dry winter season. However, threshing of barley is a tedious job which is usually done manually as no suitable threshing machine is available. This research project aimed to develop a small scale barley thresher for the smallholder farmers. Following the design of a European model, a prototype barley thresher was fabricated at Mahabub Engineering Works, Jamalpur by reverse engineering. It is powered by a 750 W electric motor. It consisted of a peg-tooth type threshing cylinder that rotates at 1800 rpm, a blower that rotates at 1200 rpm, a feeding chute, a straw outlet chute and a grain outlet chute. It is a hold on type thresher and harvested barley plants, in bundles, are hold and hand rotated on the threshing cylinder until threshing is completed. Preliminary laboratory testing of the thresher with two feed rates (250 g and 400 g) of unhulled barley variety at a moisture content of 16% (wwb) suggests that the performance of the thresher was not up to the mark as the threshing and cleaning efficiencies were low (<68%). Moreover, 31–42% grains remained unthreshed. The average power requirements at 250 g and 400 g feed rates were 510 and 523 W, respectively which were well within the capacity of the motor. However, peak energy requirements at both the feed rates were higher than the capacity of the motor indicating that a higher capacity motor (1.5–2.0 kW) would be required for safer operations and further testing at any higher feed rates during the next years. Results also showed that a high feed rate gives higher energy efficacy, but would reduce the threshing performance. To improve performance of the thresher, fine tuning its design and setting followed by wide laboratory and on-farm testing is suggested.

Development and adoption of suitable technology for hygienic potato chips production

Excessive production of potato in Bangladesh leading the necessity of alternate use for local consumption. Potato chips are popular food all over the world. Traditional potato chips making in Bangladesh is a crude and not hygienic method. Traditionally potato is sliced by knife (Boti) and dried in open sun. This method requires much time (2–3 days) and dried potato slices tuned into black colour. A study was conducted during 2019-20 to improve and adopt BARI slicer, solar tunnel dryer and spiral potato slicer for value addition for rural region to produce hygienic potato chips. The development works were done at FMPE Division, BARI and the adaptive trials were done at Bogura, Joypurhat and Tangail (Modhupur). The modified slicer was made of stainless steel and achieved minimum thickness of the slices as 1.0 mm. Capacity of the slicer was same as before (60 kgh^{-1}) but numbers of slices were increased having lower thickness. A low cost solar tunnel dryer was developed with capacity of 10 kg potato slices per batch. The time required for drying potato with 85% (wb) moisture content to 9.5% (wb) was 6 hours. The dryer temperature in the dryer was 10-15 $^{\circ}C$ higher than the ambient temparature. The dryer was used by nine farmers and total 2810 kg fresh product was dried to get 510 kg dried product during 2019-20. A spiral potato slicer was developed for producing fresh to roasted spiral potato chips. The thickness of the slices was 2.17 mm. The capacity of the spiral potato slicer was 8.55 kgh^{-1}. The weight of the spiral slicer was 3.0 kg. The complete study could not be possible due to COVID-19. Further study and economic analysis will be done in the next year.

Up-scaling and application of solar photovoltaic pump for smallholder irrigation and household appliances in the central coastal region of Bangladesh

Bangladesh is endowed with abundant supply of solar energy. At present, expensive photovoltaic (PV) cell was the main reason for its low acceptance. But with the advancement of technology, the price is declining remarkably. Solar-powered irrigation systems are increasingly in demand in developing countries. Thus, BARI has developed a solar pump based solar home system. Six solar pumps along with SHS (solar home system) were installed for field trials in the six upazila along with 1300 W_p solar panel for each pump. Two field experiments were conducted in the research field of FMPE Division, BARI, Gazipur for testing of solar pump drip irrigation system during rabi season of 2018-19. The tested crops were tomato (Roma VF) and brinjal (BARI Begun-8).Significantly the highest tomato and brinjal yields were found from drip irrigation than furrow irrigation method. There were no significantly differences of yields among three days five days, seven days intervals of water application in drip irrigation method. Drip irrigation saved about 52% and 34% water than furrow irrigation for irrigation in tomato and brinjal, respectively. In the farmers' fields, field experiments were conducted with three treatments such as drip, alternate furrow and farmers' practice (Full furrow irrigation). In the farmers field significantly the highest yield was obtained from drip irrigated tomato and brinjal. Irrigation water saving by alternate furrow and drip irrigation methods for tomato and brinjal were 33 and 47% and 35 and 47%, respectively. Some crops are damaged by cyclone Amphan. SHS in all locations are running well. Three batches of trainings on operation and maintenance of solar pump and SHS was conducted in the project areas. This experiment will be continued for next year.

Performance evaluation of a BARI solar cabinet dryer for drying of vegetables in hilly area

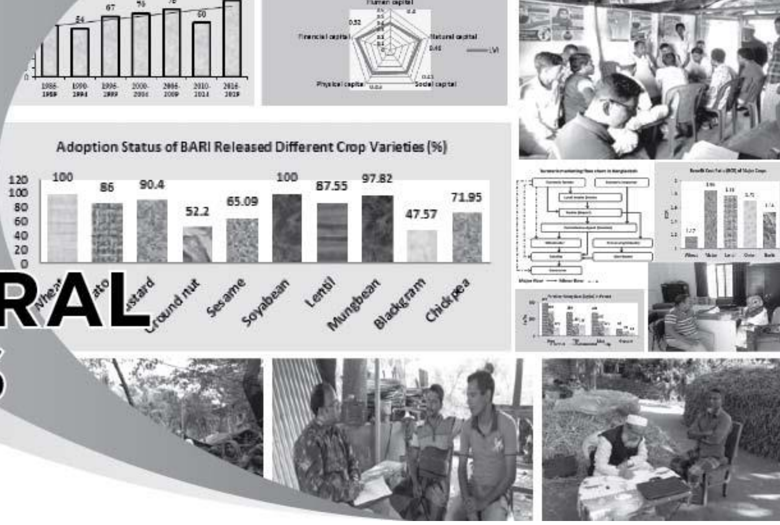
Sun drying is the most commonly used method to dry the agricultural products. In sun drying, the crop is exposed directly to the solar radiation, ambient temperature, wind velocity, relative humidity, etc. Rain, insect, human and animals interference on this method and as results the products contaminated. At hill area in Bangladesh, various vegetables have been produced and the hilly people dry their some vegetables by sun drying method and stored to consume in off season period. In this reason, a solar cabinet dryer is needed in hilly area in Bangladesh to produce good quality, safety and nutritious dried vegetables products. A solar cabinet dryer was designed and fabricated at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipurunder the project of "Development and adoption of solar cabinet dryer for vegetable seeds"financed by KGF, farmgate, Dhaka. It is an indirect solar cabinet dryer that consisted of drying chamber, collector and auxiliary heating source (electric heaters). The moist radish (9.0 kg) was collected from farmers' of Khagrachari. The dryer was tested with the moist radish at Hill Agricultural Research Station, Khagrachri during 17-18 February 2020. Drying temperature, relative humidity, air velocity and solar radiation were recorded. After drying, final weight of radish was 554 g. Inside air temperature of the drying chamber varied from 45.45˚C to 52.5 ˚C (first day) and 47.44 ˚C to 52.5 ˚C (second day). Air relative humidity in the drying chamber varied from 13.2 to 20.5% (first day) and 11.5% to 18.5% (second day), whereas the relative humidity in the ambient varied from 30.54 to 67.47 % (first day), and 42.25 to 65.25 % (second day). Collector outlet air relative humidity was found lower than the ambient air relative humidity. The global solar radiation varied from 50 to 900 Wm^{-2} during testing period. Moist radish dried in the dryer attained final moisture content of 9.0 % (wb) from an initial moisture content of 94% (wb) after 11 hours of dryingperiod whereas, it took fifty-six hours to reduce the moisture content to 12% (wb) of similar sample in open sun. In open sun drying method 9.0 kg moist radish dried to 380 g. In open sun drying method radish losses by 30% during drying as a result of fungus's attack. The capacity of the dryer was 18-20 kg per batch.Color of dried slices in dryer was more brightness and smell was good compared to sun drying of radish slices. The dryer maintained nutrition and made hygienic and safety products of radish slices. Hilly farmers and small scale traders would be benefited using the BARI solar dryer.

Development and adoption of a solar cabinet dryer for vegetable seeds

A solar cabinet dryer was designed and fabricated at Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur for drying of 10–20 kg of moist vegetable seeds.Dried seeds of red amaranth (7.95 kg) was used for testing the performance of the dryer during 30-31 January 2020. The moisture of red amaranth was reduced from an initial moisture content (17.76% wb) to the final moisture content of about 7.0% (wb) in 8 hours. Dryer was tested using alone electric energy (5 kW electric heaters) without load. Temperature of drying chamber increased and relative humidity decreased with the exposure period. Average temperature in the heater zone was 10.4 °C higher and relative humidity was 31.1% lower than those of ambient conditions. Solar energy was also used for testing of dryer without load. Drying air temperature of bottom tray was higher (1.21°C) than that of top trays but at successive upper trays temperature was gradually decreased. Temperature of all trays varied from 42.77°C to 43.98°C which is suitable for drying of vegetable seeds. Dryer was tested freshly harvested seeds of sweet gourd (616 g) during 24-25 June 2020. Average temperature of heater zone, bottom tray and upper tray were found to be 43.99°C, 42.70°C and 41.57 °C and relative humidity of the said positions were 44.00%, 46.60% and 49.25%, respectively. The moisture content of sweet guard seeds was reduced from 41.59% to 9.23% (wb) in 6 hours of drying period. Germination of dried sweet guard seeds was found to be 98%. One batch of training program of solar cabinet dryer among the farmers and seed growers was conducted at RARS, Jashore 8 February 2020. Farmers of Jashore showed interest to use the dryer. Heating unit of the dryer was rearranged for minimizing temperature differences among the trays. A prototype of solar dryer was fabricated for demonstration in the project site.

Adaptive trial of BARI developed agricultural machinery for crop production in the coastal areas of Bangladesh

Smallholder Agricultural Competitiveness Project (SACP) has been implemented (especially mechanization part) in six different coastal districts by Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Gazipur during 2019-20. BARI developed six types of agriculture machinery (BARI Seeder, BARI Bed Planter, BARI Weeder, BARI Axial Flow Pump, BARI Sunflower Thresher, BARI Compost Separator) were disseminated to farmers and local service providers through 21 adaptive trials with the help of OFRD, BARI. The selected crops were soybean, mungbean, groundnut, sunflower, mustard, cowpea, maize, and wheat. In each adaptive trial, 40 farmers and service providers were participated and practically demonstrated at least one machine in the farmers' fields. Sometimes farmers operated the machine, and operating techniques and troubleshooting of the machines were taught to them. Farmers opined that the machine reduced their drudgery and cost significantly and often obtained higher yields compared to hand sowing. Additionally, sowing in lines by seeder reduced weeding labour requirement for and cost of weeding. Four local service providers in the working areas were developed. They have been earning money through providing mechanization services to the farmers. Feedbacks from the farmers as well as the LSPs were collected and took necessary measured. After observing the performance of the machine, many of the farmers were interested to buy the machines. This program will be continued next year to train the farmers/service providers/operators, disseminate the machinery, get feedback from farmers' fields and improve the machinery as needed.



12 AGRICULTURAL ECONOMICS

Cost and Return Analysis of Selected Crops in Bangladesh

The study was conducted to analyze cost and return analysis of cereals (Wheat, Maize), pulses (Lentil, Mungbean), spices (Onion, Garlic), tuber crops (Potato), vegetables (Pointed gourd, Brinjal) and fruit (Banana) cultivation in selected growing areas. A total of 4950 farmer were randomly selected for the study. Profit function was used to estimate the cost and return of the selected crops. It was observed that per hectare average total cost of wheat, maize, lentil, mungbean, onion, garlic, potato, pointed gourd, brinjal and banana was Tk.74447, Tk. 110119, Tk. 52744, Tk. 46791, Tk.174151, Tk. 220637, Tk. 230357, Tk. 219838, Tk. 217978 and Tk.273923 respectively in the study areas. Per hectare net return of wheat, maize, lentil, mungbean, onion, garlic, potato, pointed gourd, brinjal and banana was Tk.19313, Tk. 95110, Tk. 33409, Tk. 26144, Tk.130179, Tk. 157163, Tk. 90437, Tk. 139672, Tk. 140212 and Tk.326803 respectively. Per hectare BCR was estimated 1.26, 1.86, 1.63, 1.56, 1.74, 1.71, 1.39, 1.64, 2.19 for wheat, maize, lentil, mungbean, onion, garlic, potato, pointed gourd, brinjal and banana respectively. Per kg cost of wheat, maize, lentil, mungbean, onion, garlic, potato, pointed gourd, brinjal and banana production was Tk. 18, Tk. 10, Tk. 37, Tk. 37. Tk.12, Tk.28, Tk.8, Tk.8, Tk.7 and Tk. 7 respectively.

Availability and Utilization Pattern of Agricultural Waste at Household Level in Selected Areas of Bangladesh

The study was conducted to find out the types of waste materials available for recycling and their usages pattern at household level. In total 300 households were purposively selected from five districts namely Barguna, Khulna, Mymensingh, Rajshahi and Thakurgaon for this study. The study revealed that the total amount of agricultural waste produced at household level was 822 kg per month. Cowdung contributed about 65% of the total waste followed by animal feed refusal waste (11%), garbage (7%) and kitchen waste (6%). Most farmers dumped the non-utilized cowdung and wastes in a hip or pit and used them in dry season as the organic fertilizer. The next use of dry cowdung was as fuel. The uses of the rest agricultural wastes were composed, ash, refusal of cattle feed, etc. depending on the types of waste. A small portion of farmers thrown some parts of household waste into open ditches or surrounding areas. The survey also reveals that a household can reduce the chemical fertilizer cost of total Tk. 1,463 by using compost prepared at household level. Most farmers were not much aware of proper use of household waste and did not follow the scientific methods for compost preparation. There were ample opportunities of vermicomposting and its market in the study areas.

Establishment of Agriculture Research Station at Gopalgong for Developing Eco-Friendly Agriculture in South-Western Part Through Strengthening of Research: A Baseline Survey

The study was conducted focusing base line information for the project titled Establishment of agriculture research station at Gopalgong district for developing eco-friendly agriculture in south-western part through strengthening of research by using 750 samples from purposively selected five districts of the project area during October to December 2019. Proportionate stratified random sampling technique was used in selecting farm households in different farm categories. In most cases descriptive statistics were used to analyse the data.

The farmers having average farm size of 198 decimal. Some farmers owned modern agricultural machineries like STW (0.42 No./HH), PT (0.09 No./HH), thresher (0.11 No./HH), and weeder (0.17 No./HH) along with different traditional equipments. Average annual income of sample household was Tk.1,91,865 of which the highest share came from crop production (45%) followed by livestock & poultry (14%). Boro-Fallow-T.Aman was the dominant cropping pattern practiced by the farmers of Bagherhat, Khulna and Satkhira districts. The second most important cropping pattern was Fallow-Fallow-T.Aman. in Pirojpur district, whereas Boro-Fallow-Fallow was the major pattern found in Gopalgonj district. Most of the maize and wheat farmers and majority of the rice farmers used improved variety. But still some respondent farmers were using local cultivars of rice. A lion share of the respondent cultivating pulses, oilseeds, sweet potato, vegetables and chili farmers used local cultivar. Most of the banana, mango, guava, malta, litchi and dragon fruit farmers used improved variety, but still a good percentage of farmers were using local cultivars.

The profitability analysis revealed that the highest profitable crops were tomato (BCR ranged from 2.83 to 3.46), brinjal (BCR: 2.35-2.37) and potato (BCR: 1.73-2.04), and the lowest profitable crops were cereal crops (i.e. Aus, Aman & wheat) having BCR ranged from 1.07 to 1.25. Respondent farmers encountered different abiotic stresses like salinity (29%), drought (40%), flooding (25%) and heavy rainfall (32%) in the last five years. They took several actions against unfavorable climate. Farmers also faced various problems relating to crop production, processing and marketing having different magnitudes. Production related problems in the study areas were lack of improved seed (65%), scarcity of human labour (61%), lack of irrigation facility (36%), untimely rainfall (36%), lack of agricultural machinery (32%), drought (27%), adulteration of seed (23%) and pesticides (11%), and lack of technical know-how (17%). Major marketing problems were lack of fairprice (71%), low price due to traders' syndicate (24%), lack of cold storage (26%), and higher price of fertilizer (17%).

Establishing more adaptive trials and field level demonstrations with imposing new technologies and research/extension personnel should take research program for increasing cropping intensity and productivity. Excavation and re-excavation of canal and rivers are necessary for addressing water logging, irrigation and salinity problem. On the other hand, improvement of soil health, credit facility, quality seed, salt tolerant variety, training program, agricultural input should be made available to the farmers to boost up the crop production.

Study on Nutritional Status and Food Security of the People From Former Enclaves of Panchagarh District of Bangladesh

Food insecurity is an important variable for understanding the status of nutrition of disadvantaged people like enclaves households. However, after exchange of enclaves in 2015 no research was done on the nutritional status and food security of enclave's people of Panchagarh district of Bangladesh. The overall objective of the study was to examine the nutritional status and food security of the people from former enclaves of Panchagarh district. A sample of 80 enclave households from two villages was surveyed by using pretested interview schedule in January 2020. Simple random sampling technique was applied to select the sample households. Descriptive statistics and different inferential statistics were used to interpret the data. Binary logistic regression was carried out to find out the factors affecting food security of the households. Direct Calorie Intake (DCI) method was applied to know the poverty indices. Beside this, food security measurement like FCS, HDDS, HFIAS, CSI and MAHFP were used to judge the food security status of the sample households. Among the households 58.75% belonged to small farm categories following by 20% marginal and medium farm households. Lion share of the family income came from rice production (90%) following by oilseed production (55%), potato production (37.50) and selling of daily labour (28.75%). Most part of the family income of the household used for food consumption (54.4%). On an average they consume 20 food items of which their weekly per capita intake was 9726gm. Mean of weekly per capita protein and calorie intake was 240gm and 11338 Kcal respectively. Rice occupied the major contributing source of protein and calorie intake as per capita consumption of rice was highest among all other food items (4265 gm). Among the respondents 61.25% belonged to ultra poor following by hard core poor (20%) and absolute poor (7.5%). Based on FCS 81.25% of them were in poor diet clusters but consequently 91.25% of them belonged to high dietary diversity as indicated by HDDS. Assessment of CSI and HFIAS indicated that most of the sample households were suffering from moderately to severely food insecure. Total land size and family consumption were found significant factors that influence food security status of the sample enclave households. Therefore, in order to upgrade the food security status it is necessary to provide enough income earning opportunities for the sample households of enclaves in Panchagarh district of Bangladesh.

Adoption, Impact and Farmers' Perception of BARI Maize Sheller in Selected Areas of Bangladesh

The study was carried out to determine the impacts of adoption of BARI maize sheller on productivity and farm income in Mymensigh district through collection of primary data from 41 adopters and 79 non-adopters of BARI maize sheller. Propensity score matching method was used to assess the impacts of BARI maize sheller adoption. It was found that the rate of adoption of BARI maize sheller was 26.73% at farm level. Probit model showed that experience of the farmer and education enhanced the adoption of BARI maize sheller and family size had negative effect on adoption of BARI maize sheller. BARI maize sheller adoption on average increased maize productivity and farm income by 327.08 kg/ha and 34 to 65% respectively for adopters compared to non-adopters. Most farmers mentioned that non-availability of machine in peak period, broken cob and lack of cash in hand were the major problems in cultivating maize by using BARI maize sheller. Most of the respondents opined that the non-availability of machine due to lack of capital of the respondents and complicacy of receiving subsidy to purchase machine impediment availability of the machine. The study recommended to provide educational program to the farmers/operators for more efficient operation and this program should be continued until adequate awareness is created among the farmers to ensure a rapid uptake and scaling up of BARI maize sheller.

Effect of Climate Change Adaptation Strategies on Production Efficiency of Selected Pulse Crops in Bangladesh

The study was undertaken to evaluate the effect of climate change adaptation strategies on production efficiency of selected pulse crop in Bangladesh. A total of 100 (50 chickpea and 50 lentil farmers) pulse growers were selected. A multistage random sampling technique was followed to select the sample farmers. Descriptive statistics and statistical analytical tools such as multinomial logit model and stochastic frontier production function were estimated. The most common strategy followed in the study areas was increased insecticide or pesticide application (90%). From the results of multinomial logit model it implies that education, climate change awareness and extension contact had significant positive effect on choosing different climate change adaptation strategies. Stochastic frontier function revealed that seed had negative and other agrochemicals had positive and significant effect on the yield of selected pulses. Average technical efficiency of the farmers was 84% which implies that there is a scope of increasing productivity by 16% using current level of inputs by increasing the farmers' efficiency. Results also showed that the adaptation strategy (multiple planting dates) had positive and significant effect on technical inefficiency. Pulse production efficiency can be increased by eliminating the constraints to adopt climate change adaptation strategies.

Demand and Supply of Onion in the Context of Increasing Production and Imports in Bangladesh

Onion is a popular food ingredient and an integral part of curry cooking of the people of Bangladesh. Although used as a vegetable in most countries of the world, onion is a basic ingredient in South Asian food and is used as a spice in almost all cuisines. As the production of onion in Bangladesh has gradually increased in recent years, its import dependence also increases due to its increased demand. In this context of increase in production and increase in imports of onion, the study was undertaken to examine the real situation and to recommend some policy guidelines. The annual net demand for onion in 2017-18 was 22.021 lakh metric tons against net availability from local production of 13.0 lakh MT (about 25% post harvest loss accounted). Consumption of onion has increased over time. In 1995, the per capita daily onion consumption was 11.60 grams, it has almost tripled in 21 years to 31.04 grams in 2016. In 2008-09, Tk. 222.31 core was spent to import 1.346 lakh MT of onion which increased by 15.35 times in the period of 10 years to 3412.27 crore in 2017-18. Despite the increase in imports by 7.90 times, the expenditure has increased by 15.35 times. Use of high yielding varieties and technologies, expansion of onion cultivation area, import control during the production season and increased investment in onion research and storage can improve the situation.

Socioeconomic Study of Rooftop Gardening in Chattogram City Areas

The study was carried out in three selected metro areas (Panchlaish, Doubelmooring and Patenga) of Chattogram city covering 90 sample households. Purposive random sampling technique was used for selecting the sample. Findings revealed that the average rooftop space per household was recorded as to be 1857 sq. feet; whereas 1268 sq. feet was under rooftop garden, 391 sq. feet was identified as considerably potential space for expanding the garden and 588 sq. feet was remained as open. All of the gardens were installed at 2-10th stories of the buildings. About 27 types' of vegetables, 39 types of fruits, 11 types of spices and 22 types of flower/ornamental and medicinal plants were found to be grown in the current RTG's irrespective to all areas. Ten sources were identified for collecting seeds, seedling and sapling. About 16 types of containers were used for growing plants. The highest numbers of respondents (95.6%) used half plastic drum followed by earthen made tub (78,9%). The average yield was found to be higher from bottle gourd (17.98 kg/year/RTG) followed by tomato (9.33 kg/year/RTG) and country bean (8.99 kg/year/RTG). In the case of fruits, mango gave the highest yield (8.57 kg), followed by papaya (8.38 kg) and guava (7.52 kg) irrespective to all locations. Labor crisis, unreliable sources of reproductive units (seed, seedling, sapling and else), difficulties of lifting soil and other materials to the rooftop, lack of proper knowledge of crops, cropping calendar, fertilization under different container systems and unavailability of inputs nearby the houses were reportedly the major challenges for the RTG owners.

Comparative Study of Grasspea Among the IFAD Supported Farmers with other Farmers in Selected Areas of Bangladesh

Assessing the comparative study of grasspea with IFAD supported project and without project on grasspea production on three districts namely Chapainawabgonj, Rajshahi and Madaripur was made through an extensive field survey during 2019-20. The study shows that 100% farmers with project used BARI variety and without project only 18 % farmers used BARI variety. The study revealed that average variable cost, total cost, gross return, gross margin were Tk. 17826, Tk. 46298, Tk. 46395, Tk. 28569, respectively for IFAD supported farmers and on the other hand without project these were Tk. 15696, Tk. 44202, Tk. 36385 and Tk. 20689, respectively. Benefit Cost ration (BCR) on variable cost cost basis for IFAD supported farmers was 2.61 and without project it was only 2.33. Almost all the farmers responded that more number of training is important to know about new variety, improved production technology etc. Value addition concept is new to the farmers as most of them didn't involve directly on value added product. All the farmers responded that no of women training is necessary for capacity building on value addition.

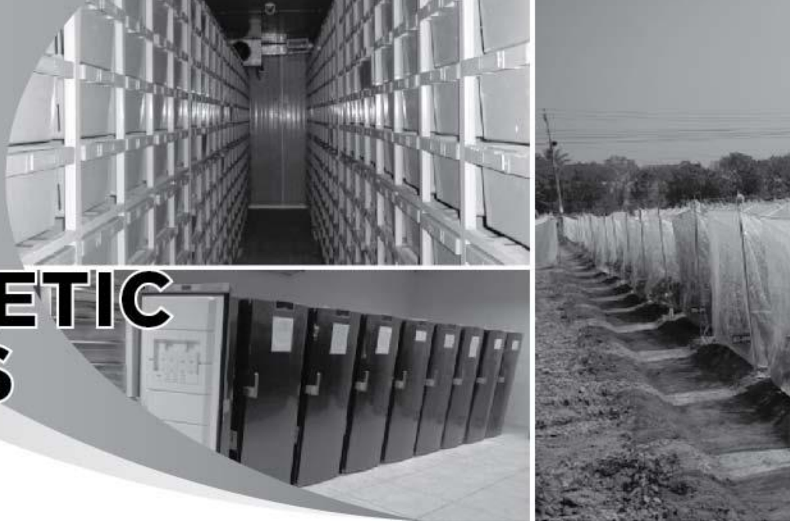
Production and Value Chain Analysis of Lentil in Selected Areas of South Western Bangladesh

The study assessed the value chain analysis of lentil in selected areas of south western Bangladesh. Data were collected randomly from 96 selected lentil farmer, local trader, arathder, retailer and miller from Jashore, Jhenaidah and Kushtia district. The results indicated that most of the farmer of the study areas were cultivated BARI Masur-8, BARI Masur-7 and BARI Masur-6 which were popular and prominent varieties release from BARI. On an average, total production cost of lentil was Tk. 66374/ha, where as variable cost was Tk. 35404/ha and fixed cost was Tk. 30970/ha. Average yield of lentil was 1.63 ton/ha in the study areas. Gross return was Tk. 115863/ha and net return was Tk. 49489/ha. Benefit cost ratio was 1.75 that means the lentil cultivation was profitable. Milling of 1000 lentil provide 725 kg pulse (lentil) and 200 kg was husk (bran). Marketing cost of faria, bepari, wholesaler and retailer was Tk. 855/MT, Tk. 750/MT, Tk.5295/MT and Tk. 1580/MT respectfully. RetailerS net margin was highest (Tk. 4945/MT) but they sold daily average 9.28 kg lentil only. Retailers was the added highest value Tk.6525/MT (44.85%) followed by wholesaler Tk.5525/MT (37.97%), faria (10.31%) and bepari Tk. 1000/MT (6.87%) respectively. Total value added at different actors was Tk. 14550/MT. Bad weather and disease infestation were the major problems in lentil cultivation.

Identification of best Agricultural Practices and Cropping Patterns in Selected Areas of Mymensingh District

The study was carried out in two selected villages namely Nouder and Akhrael under the upazila of Trishal in Mymensingh district with view to identify the best agricultural practices and cropping pattern. Net cropped area (NCA) is 24150ha and Productivity of crop is 240%. The most dominant cropping pattern Boro-Fallow-T.aman occupied 58% of net cropped area (NCA). Boro- T.aus-T.aman cropping pattern ranked the second position which covered 13% of NCA. A total of 33 cropping patterns were identified in the Trishal upazila of Mymensingh district under this investigation. The study revealed that the average homestead area was found 0.05 ha. Per household average single, double and triple cropped area was estimated at 0.04ha, 0.21ha and 0.17ha. It was reported that after the rice cultivation the bottle gourd(26.7%), cucumber (53.3%), aroid (43.3%), lades finger (40%), bean (20%) brinjal (13.3%), lalshak (10%), tomato (13.3%), potato (23.3%), bitter gourd (18.3%) cabbage (15%), steam amaranth (10%) and chili (30%) were found as the major vegetables crops. Considering the Boro-Fallow-T.aman rice cropping pattern, the production cost, gross return, net return and BCR were estimated Tk.155154, Tk.207172, Tk.52288 and 1.34 respectively in the study area. In Boro- T.aus-T.aman rice cropping pattern, the production cost, gross return, net return and BCR were estimated Tk.223293, Tk.295832, Tk.72539 and 1.32 respectively and in Vegetables-Vegetables-Vegetables cropping pattern, the production cost, gross return, net return and BCR were estimated Tk.293671, Tk.635616, Tk.341945 and 2.16 respectively.

13 PLANT GENETIC RESOURCES



Exploration and collection of plant genetic resources during 2019-20

Multi-crop exploration and collection programs were undertaken in 40 upazilas of 19 districts in Bangladesh during 2019-20. Five hundred and sixty-eight (568) germplasm of 65 crops were collected from Bandarban, Bramanbaria, Chottogram, Cox's Bazar, Dhaka, Dinajpur, Jamalpur, Jashore, Jhenaidah, Khagrachari, Khulna, Kushtia, Mymensingh, Natore, Pabna, Panchagarh, Rajshahi, Rangamati and Thakurgaon. The germplasm were 11 cereals, 72 pulses, 19 oilseeds, 388 vegetables, 36 spices, 30 fruits and 12 other crops. These germplasms were collected from home garden, field, threshing floor, farm store, cultivated habitat, market etc. The samples were collected as seeds, seedlings, fruits from individual plant or population. Passport data like collector's number, local/cultivar name, date of collection, donor's name, name of village, union, upazila and district also GPS reading of the locations were recorded. The samples were registered in germplasm collection register and conserved in active collection following appropriate procedures.

Characterization of brinjal germplasm (Set-I)

Brinjal is an important popular year-round fruit vegetable in Bangladesh. The experiment was conducted with 126 germplasm and 4 check varieties of brinjal at Plant Genetic Resources Centre (PGRC) of BARI, Gazipur, during winter 2019-20 to find out the variability in the germplasm. Descriptive statistics and analysis of variance revealed a wide range of variability for morpho-physiological traits. Estimated broad-sense heritability (h^2) for all the measured traits ranged from 10.6% to 93%, indicating that all the traits were highly inheritable. Genetic variances were low to high for most morpho-physiological traits, indicating complex genetic architecture. Yield per plant was significantly correlated with Fruit diameter, number of fruits per plant, percent fruits infestation by brinjal shoot and fruit borer and fruit weight traits, indicating that direct selection based on fruit number and fruit weight might be sufficient for improvement of other traits. The first two principal components (PCs) explained about 82.36% of the total variation among accession for different brinjal morpho-physiological traits. Genotype by trait (G×T) biplot revealed superior genotypes with combinations of favorable traits. The average genetic distance was 3.53, ranging from 0.25 to 20.01, indicating high levels of variability among the germplasm. Heatmap explaining the overall performance of the genotypes indicated that the genotypes MRI-110, MRI-101, N-215, MRI-113 and MRI-115 higher yield potentiality. Therefore, selection of these genotypes might play a significant role for future breeding program.

Characterization of brinjal germplasm (Set-II)

The study was conducted at Regional Plant Genetic Resources Center, Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2019-2020 to identify the important traits of brinjal accessions. The experiment involved thirty six brinjal germplasm. Variations among brinjal accessions were observed in different qualitative characteristics. Upright, intermediate to prostrate plant growth were observed. Leaf bade lobing was found weak, intermediate to strong and very acute, acute to intermediate in leaf blade tip angle were observed. Variations were found in number of prickles and leaf hair. Among the accessions different flower colour were observed like pale violet, light violet and bluish violet. Plant growth habit was upright for 20 accessions, intermediate for 5 accessions (17.94%) and strong for 11 accessions (30.56%). Leaf blade lobing was weak for 4 accessions (11.11%), intermediate for 12 accessions (33.33%) and strong for 17 accessions (47.22%) and very strong for 3 accessions (8.33%). Fruit curvature was straight for 26 accessions (72.22%), slightly curved for 2 accessions (5.56%), curved for 5 accessions (13.89%) and snake shaped for 3 accessions (8.33%). Fruit colour was green for 13 accessions (36.11%), milk white for 5 accessions (13.89%), scarlet red for 2 accessions (5.56%), lilac grey for 3 accessions (8.33%), purple for 8 accessions (22.22%), purple black for 3 accessions (8.33%) and black for 2 accessions (5.56%). Variations among brinjal accessions were observed in respect of days to first flowering, days to first edible fruiting stage, plant height, number of fruits per plant, fruit weight (g), fruit weight per plant (kg) and 100- seed weight. The first flower initiation was noticed in SM Ish-017 (82 days). The highest fruit weight per fruit (266.38 g per fruit) was recorded from SM Ish-001 and the lowest fruit weight (77.65 g per fruit) from SM Ish-014. The highest fruit weight per plant (5.38 kg per plant) was recorded from SM Ish-015 and the lowest fruit weight per plant (2.09 kg per plant) from SM Ish-032.

Characterization of mungbean germplasm

Ninety one (91) germplasm with 6 cheak varieties of mug bean (*Vigna radiata*) were characterized at plant Genetic Resources Centre, BARI, Gazipur during 2019-20. Qualitative variations were observed; Sparse (43.96%), medium (58.56%) and abundant (8.79%) were exhibited in leafiness followed by Deltoid (63.92%) and ovate (36.08%) such variation found in the terminal leaflet shape. Petiole length such as short (58.76%) and medium (41.24%); raceme position such as mostly above canopy 50.82% and intermediate 49.48% were observed. The maximum range of yield/plant was 5.75 to 338.24 gram followed by number of pod per plant was 3.24 to 85.46 and mean 24.25. In plant height, mean was 40.97cm and range, 22.50to 73.70 cm, in number of seed per pod range 10.52 to 35.30and mean 22.37. The maximum coefficient of variation 92.68% was obtained from yield per plant followed 69.91% no. of pod/plant 26.69%, no. of primary branches/plant, 25.40% 100 seed weight. The frequency distribution observed higher on number of seed per pod and medium on days to 1st flowering and yield per plant. Unique selection and trait information is available within the population studied which may offer crop improvement opportunity.

Characterization of ash gourd germplasm

Ash gourd (*Benincasa hispida* Thumb.) is an under-exploited but important summer vegetable crop in which genetic diversity. The study was executed in the experimental field at the Plant Genetic Resources Centre (PGRC) of BARI, Gazipur during the *Kharif* season 2019-20 to access the genetic diversity of the collected germplasm. 100 ash gourd germplasm were used in this experiment. Out of them, 80 germplasm were germinated. After transplanting 12 germplasm were damaged. So existing was 58 accessions. All the germplasm were collected from the different areas of Bangladesh. Germplasm was varied for different qualitative and quantitative characters. Qualitative variation was found in early plant vigour, leaf size, fruit shape, mature fruit skin colour and fruit skin lustre. The highest coefficient of variation was found in germination percentage (56.57%) which was followed by the number of fruit plant^{-1} (45.83%). The lowest coefficient of variation was obtained in days to 1st female flower (13.06%) which was followed by fruit breadth (14.34 cm) and petiole length (15.03 cm). Based on the growth behavior, survival capacity under rough weather as well as yield the germplasm KMR-206, KMR-241, N-22, TRMR-125 and NTR-8 were found better and accession AMA-83, AMA-114, KMR-241, KMR-292 and TRMR-125 found not good among the germplasm which can be used in the future improvement or breeding program.

Characterization of yard long bean germplasm

The experiment was conducted with 46 germplasm of yard long bean (*Vigna unguiculata* L.) in the experimental field at Plant Genetic Resources Centre (PGRC) of BARI, Joydebpur, Gazipur, during winter 2019-20 to find out the variability in the germplasm. All the qualitative characters showed distinct variation among the germplasm except immature pod pigmentation, seed shape and eye colour. The maximum variation observed in stem colour, leaflet shape and immature pod colour. Quantitatively highest variation was observed in yield per plant (CV- 89.74%) which was followed by number of pods per plant (CV- 47.71%) and 100 seed weight (g) (CV-40.05%). Time required to first fruit setting ranged from 67 to 98 days with an average of 79.87 days. The early fruiting germplasm were NT-18, AHI-75, NTR-22, N-183, SU-16, NTR-16, AMA-190, TRMR-66 and RC-191 and the late fruiting germplasm were NRI-227, NQR-30, B-8, AHM-70, N-76, SA-73, N-131, NRI-273 and AHM-49. The best yielding germplasm were NSR-94 (2.52 kg), NSR-148 (2.58 kg) and KASI-35 (2.88).

Characterization of sesame germplasm

Seventy-three germplasm of sesame were evaluated during *kharif-1* season of 2019-20 at the Plant Genetic Resources Centre of BARI, Gazipur to characterize indigenous sesame germplasm through qualitative and quantitative characters to identify the promising germplasm and provide genetic diversity for crop improvement program. Some qualitative and quantitative data were recorded. Minor qualitative variation was observed among the germplasm. Due to COVID19 pandemic situation and heavy rainfall during flowering time maximum traits were not taken properly. So, repet the experiment will be continued next year.

Characterization of bottle gourd germplasm

Characterization and genetic variability for 34 characters in 218 germplasm and 5 check varieties of bottle gourd (*Lagenaria vulgaris*) were studied. All germplasm showed variation in qualitative and quantitative traits. Significant differences were observed among the quantitative traits. In qualitative traits, variability was found in fruit shape, matured fruit skin colour, early plant vigor, leaf margin. The Maximum variation was observed in fruit shape such as Globutar, Oblong blocky, Pyriform, Dumbbell, Elongate form, Curved and Crocked neck. Among the total germplasm (223 acc.) 8.97% globular (20 acc.), 4.04% Oblong blocky (9 acc.), 62.78% pyriform (140 acc.), 0.456% Dumbbell (1 acc.), 15.70% elongate form (35 acc.), 0.456% curved (1 acc.) and 7.62% crooked neck (17 acc) followed by matured fruit skin colour such as creamish, yellowish and green. These were 39.46% creamish (88 acc.), 56.95% yellowish (127 acc.), 3.59% green (8 acc.). Early plant vigor *viz.*, poor 23.32% in 52 acc., good 46.19% in 103 acc. and very good 30.49% in 68 acc. were found. Variation was observed on leaf margin, 93.29% germplasm showed entire margin and 6.73% germplasm showed serrate leaf margin. The range of number of fruits per plant was 1 to 7, fruit weight at matured stage was 1.28 to 15.64 kg, days to edible fruit was 108.77 to 140.17 days and yield per plant was 1.92 to 55.98 kg. The highest stander deviation (SD) was found in petiol length (12.02) and the lowest in number of fruits per plant (1.75). The maximum coefficient of variation was obtained on 1000 seed weight (252.29%) followed by days to edible fruit (125%), days to 1st female flower (96.35%).

Characterization of hyacinth bean germplasm

The experiment was conducted on hyacinth bean (*Lablab purpureus L.* Sweet) at Plant Genetic Resources Centre (PGRC) of BARI, Joydebpur, Gazipur, during November 2019 to May 2020 to estimate the characterization and variability in the germplasm. In present study, the germplasm was grown in augmented RCBD design including 60 germplasm with four check BARI released varieties. Green and purple colors were found in hypocotyl, epicotyl and leaf vein among the germplasm. Leaf anthocyanin was observed 26.56% among the germplasm. Hundred percent indeterminate climber of growth habit, glabrous of leaf hairiness and pod pubescence were found. Variations were observed in ramification index and stem pigmentation. The germplasm were shown white, cream, light yellow, pink and purple color of different flower parts such as flower bud, standard petal, wing petal as well as also pod color. Different pod shapes and pod curvatures were found. Variations of fresh seed color and dry seed color such as cream, purple, brown and black were exhibited. Days to first flowering were ranged from 56.75 to 87.94 days and edible pod stages were ranged from 85.12 to 116.87 days. The higher amount of coefficient of variations were observed in the number of pods per rachis, edible pod length and width as well as yield per plot whereas low variation was found in leaf and seed size.

Phenotypic variance was higher than the genotypic variance for all the traits thus indicated the influence of environmental factors of all the traits. In the study heritability (%) range from 35.81 to 97.9. High heritability estimates were obtained for number of leaf length which was followed by leaf breadth, seed length, seed weight and yield per plot. Here most of the characters were shown high heritability that was above sixty percent except the lowest heritability was found pedicle length. The highest genetic advance was found in hundred fresh seed weights (49.55) whereas the lowest genetic advance was seed breadth (0.13). The genetic advance ranged from 0.13 to 49.55 indicating high levels of variability among the germplasm. The germplasm AC-202, AC- 209, TT- 137, AC-479, AHI-12, SAU-2 and TT-91 might be considered as the good yielder among the study.

Characterization of sponge gourd

Seventy-three (73) accessions of sponge gourd (*Luffa cylindrica*) were characterized at Plant Genetic Resources Centre (PGRC), RARS, Jamalpur. Qualitative variations were observed in leaf shape, leaf margin, dorsal leaf pubescence, ventral leaf pubescence, flower color, fruit shape, flesh color, fruit color, fruit skin texture, flesh flavor, flesh taste, skin hardness, fruit size variability and seed colour. In the quantitative traits highest fruit/plant was found in accession BD-2369 (48) followed by the characters fruit yield/plant in accession BD-2369 (8.61kg) and fruit weight in accession AC-308 (195.23 g). Early flowering, first harvest for vegetable use and maturity was observed in accession SA-71 (43 days), AMA-321 (53 days) and BD-2364 (170 days). Maximum number of lateral shoot was found in accession AHM-122 (7) followed by the characters last harvest for vegetable use in accession BD-1688 (179 days), hundred seed weight in accession AMA-104 (12.02 g), fruit length in accession IAH-170 (29.37 cm), fruit width in accession BD-2372 (18.98 cm) matured fruit length in accession MK-85 (44.14 cm) and matured fruit weight in accession AC-308 (213.72 g). The highest coefficient of variation (CV %) and standard deviation were observed in the characters fruit yield/plant (60.72) and matured fruit weight (30.70). Unique selection and trait information is available within the population studied which may offer crop improvement opportunity.

Characterization of amaranth germplasm

Efficient utilization of plant genetic resources for nutrition and crop improvement requires systematic understanding of the important traits. *Amaranthus* species are distributed worldwide with an interesting diversity of landraces and cultivars whose leaves, stems and seeds are consumed. In the current study eighty accessions of amaranth (*Amaranthus* spp. L.) were studied in augmented block design at the Plant Genetic Resources Centre (PGRC) of BARI, Gazipur during winter 2019-20 to acquire the knowledge about diversity of this crop. All the accessions demonstrated variations both for qualitative and quantitative characters. Qualitative variation was found in different parameters as early plant vigor, plant growth habit; compactness, shape and spininess of inflorescence; texture of stem and so on. Moreover, different color variations were displayed in leaf (green 17.5%, reddish green 16.25%, red 6.25% and dark red 60%), inflorescence (yellowish orange 1.25%, purple 5%, red 3.75%, reddish green 61.25% and green 28.75%), stem (72.5% red, 6.25% reddish green and 21.25% green), and seed (black 50%, red 48.75% and greenish 1.25%). Additionally, in case of quantitative character, mean plant height was 98.45 cm. Also, the plants of different accessions flourished with 50% flower within 50-79 days giving 13.53 cm long inflorescence on an average. Average seed yield per plant was 9.11 g, where 1000 seed weight ranged from 0.61 to 1.2 g. Nevertheless, highest CV was found in case of seed yield per plant (68.21%) and the lowest in number of days to 50% flowering (13.41%). Lastly, accessions, namely BD-2961, BD-9790, BD-9795 and BD-9825 from leaf amaranth and BD-9822, BD-9941 and BD-9942 from stem amaranth can be recommended for using in future breeding program.

Characterization of jackfruit germplasm

The present study was aimed to *in situ* evaluation of jackfruit germplasm at BARI campus, BARI, Joydebpur, Gazipur based on qualitative and quantitative traits for find out the variability in the germplasm during 2019-20. The experiment was conducted with 96 selected tree of jack fruit. Due to COVID19 pandemic situation all traits dose not recorded according to IPGR, 2000 descriptor only few traits like GIS position of the tree, approximate age of the tree, plant height, were recorded. Based on recorded data it was observed wide range of variations were found in most of the traits which indicates scope for tree breeding planning.

Characterization of guava germplasm

Guava (*Psidium guajava* L.) is an important commercial fruit in Bangladesh. The study was conducted in the fruits orchared of Agriculture Research Station (ARS), Pahartali, Chattogram and Resional Agriculture Research Station (RARS), Hathazari, Chattogram during 2019-20 to assess the genetic diversity of the *in situ* guava germplasm. 22 guava genotypes were evaluated in this experiment. A total of 21 traits (11 qualitative and 10 quantitative) enabled an assessment of the genetic variability and structure of this guava germplasm. The maximum variation was observed in pulp colour and seedness in guava fruits. The highest quantitative coefficient variation (%) was observed in yield per plant (94.04%) followed by individual fruit weight (68.59%). Plant height ranged from 2.38 to 6.20 m with an average 3.58 m. Based girth ranged from 33.306 to 81.00 cm with an average of 47.79 cm. Fruit weight ranged from 55.0-362.0 g with average 101.92 g and yield per plant ranged from 12.53 to 126.70 kg with average 26.54 kg. The first two principal components (PCs) explained about 98.46% of the total variation among germplasm for different guava morpho-logical traits. Genotype by trait (G×T) biplot revealed superior genotypes with combinations of favorable traits. The morphological dendrogram generated from agglomeration hierarchical clustering grouped the 22 genotypes into 5 major clusters. Heatmap explaining the overall performance of the genotypes indicated that the genotypes PG Hat 017, PG Hat 012, PG Pah 07, BARI Peyara-2 and BARI Peyara-4 higher yield potentiality. Therefore, selection of these genotypes might play a significant role for future guava improvement program.

Characterization of rapeseed germplasm

Fifty (50) genotypes of rapeseed were characterized at Plant Genetic Resources Centre (PGRC), RARS, Jamalpur. Qualitative variations were observed in seedling leaf marginal incisions, seedling leaf colour, seedling pubescence, mature leaf shape, mature leaf colour, leaf pubescence, petal colour and siliqua colour. In the quantitative traits highest seed yield/plant was found in genotype R-JAM BC-094 (24.51 g) followed by the characters length of main inflorescence in genotype R-JAM BC-078 (62.25 cm), number of secondary branches/plant in genotype R-JAM BC-097 (15), number of siliquae/plant in genotype R-JAM BC-097 (343) and seeds/siliqua in genotype R-JAM BC-077 (23). Early flowering, days of flower completion and early maturity was found in R-JAM BC-082 (29 days, 46 days and 74 days). Maximum number of primary branches/plant was found in genotype R-JAM BC-097 (10) followed by the characters plant height in genotype R-JAM BC-096 (150.76 cm), siliqua length in genotype R-JAM BC-093 (6.44 cm) and 1000-seed weight in genotype R-JAM BC-003 (6.17 g). The highest coefficient of variation (CV %) and standard deviation were observed in the characters seed yield/plant (37.89) and plant height (13.38). This study may offer a good scope for rapeseed improvement.

Morphological characterization of lentil germplasm

The study was conducted at Regional Plant Genetic Resources Center, Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2019-2020 to characterize the germplasm and regenerate seeds for conservation and to develop a photographic monograph with descriptor of the collection. The experiment involved 102 lentil accessions. Variations were observed in respect of time to flowering, time to maturity, plant height, number of seeds per pod, 100-seed weight and yield per plant among lentil accessions. The day to 50% flowering was earlier in BD-3908 (48 days). The earlier maturity was in BD-3819 (105 days) than the other accessions. Variations among lentil accessions were observed in different qualitative characteristics like plant pigmentation were observed in stems, leaves and flowers. Maximum Seedling stem pigmentation was present for 47 accessions (46.08%) and absent for 55 accessions (53.92%). Variations in tendril length were prominent maximum 43 accessions (42.16%) and rest lines were in rudimentary maximum 59 accessions (57.84%). The flower ground colour was white maximum for 78 accessions (76.47%), white with blue veins for 8 accessions (7.84%) and rest were in violet for 3 accessions (3.12%). Pattern of testa was absent for 1 accession (0.98%), dotted for 70 accessions (68.63%), spotted for 6 accessions (5.88%) where rest were in marbled for 25 accessions (24.51%). Colour pattern of testa was absent for 1 accession (0.98%), grey for 20 accessions (19.61%), brown for 65 accessions (63.73%) and where rest were in black for 16 accessions (15.69%). Cotyledon colour was yellow for 1 accession (0.98%), orange-red for 99 accessions (97.06%) and rest were in olive-green for 2 accessions (1.96%) observed. Variations among lentil accessions were also found in different quantitative characteristics. Number of pods per plant varied from 65.00 to 356.67 and BD-3896 produced significantly the highest number of pods per plant (356.67). Number of seeds per plant varied from 134.00 to 686.67. Among them, 31 accessions were highest number seeds per plant (400.00-686.67), 52 accessions were moderate number seeds per plant (201.33-386.67) and rest accessions were lowest (130.00-195.33). BD-3888 produced significantly the highest number of seeds per plant (686.67) among them. Yield varied from 1.91 g to 13.50 g per plant and the highest seed yield (13.50 g/ per plant) was recorded from BD-3904 lentil accession and the lowest yield (1.91 g/ per plant) from BD-3832 lentil accession.

Morphological characterization of chickpea germplasm

The study was conducted at Regional Plant Genetic Resources Center, Regional Agricultural Research Station, Ishurdi, Pabna during rabi season of 2019-2020 to characterize the germplasm and regenerate seeds for conservation and to develop a photographic monograph with descriptor of the collection. The experiment involved 101 chickpea accessions. Variations were observed in respect of days to first flowering, days to 50% flowering, days to maturity, plant canopy height, number of seeds per pod, 100-seed weight and yield per plant among chickpea accessions. The first female flower initiation was noticed in BD-6102 (58 days) and days to 50% flowering was earlier in BD-6111 (76 days). The earlier maturity was in BD-6105 (124 days) than the other accessions. BD-6159 produced significantly the highest number of seeds per plant. Variations in different qualitative characteristics like plant pigmentation were observed in stems, leaves and flowers. Growth habit was erect for 1.98%, semi-erect for 31.68%, semi-spreading for 44.55%, spreading for 15.84% and prostrate for 5.94% found among the genotypes. Leaf type was simple for 56.44% and multipinnate for 43.56% variations observed among them.Flower colour was dark pink for 43.56%, pink for 25.74%, light pink 25.74% and white observed for 4.95% variations. Seed shape was angular, rams head for 23.76% and irregular rounded rest was owl’s head for 75.25% and pea-shaped, smooth round were observed for 1 accession (0.99%). Testa texture was rough for 16.83%, smooth for 68.32% where tuberculated were observed 14.85% variations. Seed colour was brown for 18.81%, light brown for 6.93%, dark brown for 23.76%, reddish brown for 22.77%, greyish brown for 12.87%, yellow for 5.94%, light yellow showed 1 accession (0.99%), yellow brown for 4.95%, orange-yellow for 1.98% and orange were observed for 1 accession (0.99%) variation. The number of pods per plant varied from 22.00 to 288.00. Yield varied 3.78 g to 56.45 g per plant, Among 101 chickpea accessions, BD-6099, BD-6100, BD-6102, BD-6132, BD-6140, BD-6135, BD-6147, BD-6159, BD-6170, BD-6171, BD-6175, BD-6176, BD-6177, BARI chickpea-5, BARI chickpea-9 and BARI chickpea-10 showed high yielding (40.67−56.45 g per plant). The highest seed yield (56.45 g per plant) was recorded from BD-6159 chickpea accession and the lowest yield (3.78 g per plant) from BD-6039 chickpea accession.

Morphological characterization of pigeon pea germplasm

The study was conducted at Regional Plant Genetic Resources Center, Regional Agricultural Research Station, Ishurdi, Pabna during *rabi* season of 2019-2020 to characterize the germplasm and regenerate seeds for conservation and to develop a photographic monograph with descriptor of the collection. The experiment involved thirty one pigeon pea germplasm. Variations were observed in qualitative and quantitative characteristics among the 31 pigeon pea accessions. From growth habit observed as erect and compact for 25.81%, semi-spreading for 6.45%, spreading for 19.35% and trailing found 48.39% variations. Stem colour was green for 3.23%, sun red for 12.90%, purple for 41.94% and dark purple found 19.35% variations. Leaflet shape varied lanceolate for 16.13%, narrow-elliptic for 12.90%, broad-elliptic for 61.29% and obcordate found 9.68% variations. Base flower colour observed as ivory for 6.45%, light-yellow 29.03%, yellow 48.39% and orange-yellow found 16.13% variations. Pattern of streaks varied as medium amount of streaks for 70.97% and dense streaks found (29.03%) variations. Base seed colour varied as cream for 6.45%, orange for 12.90%, light brown for 9.68%, reddish-brown for 29.03%, purple as 7 accessions for 22.58%, dark purple 1 accession for 3.23% and dark grey found 3.23% vaiations among the accessions. Seed shape observed oval as 7 accessions for 22.58%, globular 10 accessions for 32.26% and square found 14 accessions for 45.16% variations.Hilum was absent as 8 accessions for 25.81% and present found as 23 accessions for 74.19% variations among 31 accessions of pigeon pea.Days to 50% flowering found early the accession BD-3112 (181.00 days). The duration of flower varied from 211.00 days to 279.00 days. Days to 75% maturity varied from 260.00 to 319.00 days. Plant height varied from 221.17cm to 415.00cm. Raceme number varied from 50.33 to 141.00. among the germplasm 8 accessions showed highest raceme number per plant (101.00−141.00). The number of pods per plant varied from 118.33 to 1436.11. Among the genotypes, 2 accessions showed highest number of pods per plant (1071.23−1436.11), 8 accessions gave moderate number of pods per plant (645.68−960.82) and rest lines produced lowest number of pods per plant (118.33-569.57). 100-seed weight varied from5.80 g to 14.00 g.Yield per plant varied from 51.33 g to 517.00 g, where BD-3111, Nouga Local, BD-3133 and BD-3121 were high yielding (314.00− 517.00 g per plant). The highest seed yield (517.00 g per plant) was recorded from BD-3111 pigeon pea accession and the lowest yield (51.33 g per plant) from BD-3125 pigeon pea accession.

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 programs. In this study 120 genotypes were taken to characterize with the help of SSR markers to reveal the genetic diversity among genotypes of oilseed *Brassica* species. All the primers selected for this study has been responded to SSR marker selection study. Among them tested 17 (seventeen) microsatellite markers were found to be polymorphic conferring to previous study. However, results revealed that, considerable diversity was present amid the germplasm.

Conservation of germplasm in active and base collection

Plant Genetic Resources Centre (PGRC) acts as a germplasm store house of the BARI mandated crops viz. cereals, pulses, oilseeds, vegetables, fruits, spices and other crops etc., since 1987. The accessions were conserved in medium-term storage (4 to 6^{0}C) and long-term storage (-18 to -22^{0}C). Viability (germination %), quantity and moisture were checked before conservation. Accessions having less than 80% viability and/or less quantity of seeds were regenerated. Generally, the seeds were dried at 6-8% moisture content before storing. Till now, the Centre has conserved 11188 (eleven thousand one hundred and eighty-eight) accessions of 82 different crops in its gene bank. Among them, 1768 accessions were cereals, 3553 pulses, 602 oilseeds, 439 spices, 4486 vegetables, 283 fruits and 57 other crops. In 2019-20, a total of 107 germplasm were assigned as new accession and were conserved in gene bank of PGRC.

Monitoring of germplasm in active and base collection

The monitoring of 809 accessions from different year (batch references) among seven important crops viz. Sorghum (268), Indian spinach (73), groundnut (23), sunflower (56), ash gourd (250), bitter gourd (135) and batishak (4) were tested in 2019-20 by germination test. Among the monitored germplasm 445 accession from active collection and 364 accessions were from base collection. The viability test was conducted on germination paper, sands and pulverized gravels. Combining all data, it was found that less than 40% germination was higher but 41-80% germination and 81-100% germination was found lower in case of active collection. Moreover, less than 40% germination was lower but 41-80% germination and 81-100% germination was found higher in case of base collection. Collectively, base collection performance was good over the active collection. The accessions having less than 80% germination and or less quantity will be regenerated in the following year.

Comparative analysis of seed quality parameter of sorghum and muskmelon germplasm 25 years stored

Ex situ conservation are an efficient and cost-effective way of conserving large amounts of genetic diversity. Seed gene banks maintain genetic resources of the seeds over decades or centuries. The aim of this study was to evaluate the effect of the medium and long-term gene bank storage from a practical point of view for the sorghum species maintained for more than 25 years according to the recommended cold temperature. A total of 100 accessions of sorghum and muskmelon stored since 1992–1993 in the PGRC, Genebank of BARI were evaluated. All seed accessions were maintained as active and base collections under medium and long-term storage conditions with low moisture contents (5±2%) in poly bag and laminated aluminum foil packets at 4°C and –22°C, respectively. The seed storage characters σ (standard deviation of seed death in storage), $P_{50\%}$ (the time for viability to fall to 50%) and $P_{10\%}$ (the time for viability reduction of 10%) were determined allowing the prediction of seed storage life and the regeneration needs. The results showed significant differences in loss of seed viability among accession of sorghum. After 20-25 years of storage, 40% sorghum accession showed minimal viability decline under 15% as compared to the initial viability. There was wide variation among the sorghum accessions for seed quality parameter. It can be predicted that, 50% viability reduced in sorghum after 11.51 years and 17.72 years, respectively active and base conservation in gene bank.

Distribution of germplasm

Germplasm distribution is one of the important activities of Plant Genetic Resources Centre (PGRC). The centre distributed 1250 accessions of 22 crops among the researchers, MS and PhD students, plant breeder, horticulturist and teachers of different Universities and Institutes for conducting research on varietal improvement as well as screening and evaluation like diseases, insect screening, salinity stress, mutation breeding, abiotic stress, fibre production, draught tolerant and molecular diversity analysis during 2019-20. Among the germplasm, 59 accessions were cereals (wheat, barley, and buck wheat), 539 pulses (black gram, faba bean, grass pea and mungbean), 87 oil seeds (sunflower, sesame and soybean), 80 spices (chilli), 405 vegetables (amaranth, brinjal, country bean, cucumber, okra, pumpkin, ridge gourd, snake gourd, sweet gourd and tomato) and 80 fruits (muskmelon). Ten to hundred seeds or 5-10 g seeds per accession were supplied to the users.

Regeneration of onion germplasm

The experiment was conducted at the experimental field of Plant Genetic Resources Centre, BARI, Gazipur during 2019-20 to conserve fourteen collected germplasm of onion whereas thirteen exotic germplasm of onion and BARI Peaz -1. During onion price market crisis in Bangladesh which were successfully grown to assist the regeneration and conservation program. The collected of exotic onion were planted on 12 December 2019 with recommended practices to get adequate quantity of seed for future use. Flowers are initiated by soaking the bulb 48h in 250 ppm GA_3 solution and spraying two times 100 ppm GA_3 at seedling stage. All the collected exotic onion exhibited greenish white color flower and black color seeds at matured stage. The crops were harvested at time to time for each collected material. The longest days to 50% flower was found at NSQ-11. The highest plant height, Flower per head and flower stalk length were found NSQ-8. The highest co-efficient of variance were recorded flower per head and hundred seed weight. Some qualitative and quantitative characters were recorded to know the overall performance of those germplasm aiming to enrich the gene bank with good reproductive units.

Regeneration of black cumin germplasm

The experiment was conducted at the experimental field of Plant Genetic Resources Centre, BARI, Gazipur during 2019-20 to regenerate conserved collector materials of Black cumin (7) name as AC-19, AC-25, AC-33, AC-327, AMA-365, AMA-350 and AR-210 which were successfully grown to assist the regeneration and conservation program. The crops were planted from 10 December, 2019 with recommended practices to get adequate quantity of seed for future use. Most of the Black cumin accessions leaves and straw color was found light green and flower color was found violet color mixed with white and light green. The maximum no. of capsule per plant and capsule weight per plant were recorded in AC-327. The earliest first flowering days was observed in AC-33 and the longest days was found in AMA- 350. An hundred seed weight ranged from 0.23 to 0.32 g The highest yield per plot was found in AC-33 (0.32Kg). Some qualitative and quantitative characters were recorded to know the overall performance of those germplasm aiming to enrich the gene bank with good reproductive units.

Regeneration of ajwain germplasm

A study was conducted in the experimental field of PGRC, BARI, Gazipur during the *rabi* season of 2019-20 to produce sufficient seeds to enrich gene bank. One ajwain germplasm was regenerated. The accession number was BD-4523. Some qualitative and quantitative data were recorded. After completing all the post-harvest operations, the seeds were conserved properly for future study.

Regeneration of rice bean germplasm

Rice bean (*Vigna umbellata*) is one of the minor legume crop. An experiment was executed at the Plant Genetic Resources Centre of BARI, Gazipur during the *rabi* season of 2019-20 with three germplasm of rice bean to identify their variability and to increase sufficient seeds for conservation. Some qualitative and quantitative data were recorded. Qualitative variation was not found among the germplasm. Some of the variations were observed in quantitative characters.

Regeneration of faba bean germplasm

The study was conducted at the Plant Genetic Resources Centre, BARI, Gazipur during the *rabi* season of 2019-20 with thirteen germplasm of faba bean (*Vicica faba*) to identify their variability and to increase sufficient seeds for conservation. Some qualitative and quantitative data were recorded. Qualitative variation was not observed among the studied germplasm. Variation was found in plant height, days to 50% flowering, pod length, number of pods plant^{-1}, number of seeds pod^{-1} and 100 seed weight(g).

Regeneration of vetch germplasm

The regeneration experiment was conducted at the PGRC, BARI, Gazipur during the *rabi* season of 2019-20 with three germplasm of vetch (*Vicia sativa* L.) to identify their variability and to increase sufficient seeds for gene bank. Three vetch germplasm were regenerated. Variation was found in leaf colour, seed colour, seed shape and 100 seed weight. The seeds have been conserved for future utilization and conservation.

Regeneration of grain amaranth germplasm

The grain amaranth (*Amaranthus sp*) regeneration experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during the *rabi* season 2019-20 to increase sufficient seeds for conservation. Two grain amaranth germplasm has been maintaining at PGRC, BARI. One germplasm was regenerated. The accession number was BD-20001. Some qualitative and quantitative data were recorded. An adequate amount of seeds were harvested for conservation.

Regeneration of spinach germplasm

An experiment was conducted at the Plant Genetic Resources Centre, BARI, Gazipur during the *rabi* season of 2019-20 to regenerate sufficient seeds for further use. The 30 spinach germplasm were regenerated. Some of the qualitative and quantitative characters were recorded. variation was observed in stem anthocyanin content, bolting time, days to 50% flowering, plot yield and 100 seed weight (g). An adequate amount of seeds were harvested for conservation.

Conservation of gerplasm in field gene bank

PGRC is maintaining 273 germplasm including 213 accessions of 73 crops both indigenous and exotic germplasm in the field genebank. The new 12 germplasm of 8 crops were collected from different district that has been maintaining in field gene bankat PGRC/BARI. 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.

In vitro collection of plant genetic resurces

In vitro collection of plant genetic resources was initiated as an additional tool for meeting the *ex situ* conservation and restoration goals of the Global Strategy for Plant Conservation The work was carried out at the *In vitro* Conservation Laboratory of Plant Genetic Resources Centre, BARI, Joydebpur Gazipur to collect immature plant /seed/fruit/shoot/any tissue from field or market, which had been initiated during 2018-19. Immature seed or Embryo rescue was done for summer tomato and ginger by using somatic embryo culture media *viz*. MS + 30 g Sucrose + 6 mg BAP + 8 g Agar, pH 4.0 and MS+30g Sucrose + 1.5 mg GA_3 + 8 g Agar, pH 5.6 for Shoot initiation of ginger.

In vitro conservation of bulblet of garlic

An efficient and novel method of direct bulblet regeneration from root tips in garlic was developed. The influence of growth regulators, basal media and age of root explant on shoot initiation and proliferation was examined. The best growth regulator combination was 1-naphthalene acetic acid and 6-benzyl adenine at 1.5 and 15 µM, respectively, inducing shoot initiation from 70% of the explants. The frequency of bulblet initiation on different treatments wasnot similar. Explant root tips from plantlets taken 30 to 40 days after sprouting showed the highest bulblet initiation, which had been initiated during 2018-19. Thus, it appears that the protocol is cheap, and time bound andparticularly useful for conducting experiment for encapsulated or synthetic seed for short term conservation or cryopreservation and genetic improvement of garlic.

In vitro conservation of micro rhizomes of ginger

MS medium supplemented with 9 mg/L BAP and 90 g/L sucrose under 16-h photoperiod within 10 weeks of cultivation were the best conditions for ginger microrhizomes induction. *In vitro* technology can thus become the preferred choice as it can be utilized for multiplication, conservation of genetic resources, generating variability, gene transfer, molecular tagging, and their utility in crop improvement of these crops.

In vitro conservation of somatic embryo of turmeric germplasm

MS medium supplemented with 5 mg 6-BAP + 3 mg 2,4-D + 3 mg Kinetin, pH 5.6 under 16-h photoperiod within 12 weeks of cultivation were the best conditions forturmaricembryogenesis. *In vitro* technology can thus become the preferred choice and it can be utilized for multiplication, conservation of genetic resources, generating variability, gene transfer, molecular tagging, and their utility in crop improvement.

In vitro conservation of zygotic embryo of coconut

The experiment was conducted with two locally cultivated coconut germplasm at the *In vitro* Conservation Laboratory of Plant Genetic Resources Centre, BARI, Joydebpur, Gazipur. The study investigated the effects of liquid and solid media in the propagation of coconut zygotic embryos at initiation stage. MS medium supplemented with 2 mg NAA + 2.5 g activated charcoal + 8 g, pH 5.7 were used for this experiment in both liquid and solid states. Results showed that solid state medium was better compared to liquid state. Embryo culture micropropagation has several advantages over conventional propagation methods; for instance, the production of disease free, high quality planting materials and the rapid production of many uniform plantlets in a limited space area are achievable by this technology.

In vitro conservation of potato, mint and yam

In vitro conservation of germplasm is one of the objectives of Plant Genetic Resources Centre. This is a medium-term study of *In vitro* conservation of

8 potato (*Solanum tuberosum* L.) varieties, 3 mint (*Mentha* spp.) genotypes and 5 yam (*Dioscorea alata*) accessions which had been initiated during 2014, 2014 and 2017 correspondingly. Germplasm are being cultured on MS media at 22^0C and 60-70% humidity for *In vitro* conservation. Time to time sub-culture is being performed. However, attempt to callus culture of the germplasm has been successful. Conservation of these germplasm is going on and will be continued.

Embryo rescue of brinjal interspecific hybrid for discovering new traits

Wild relatives of eggplants represent a good source of variation for breeding programs, in particular for traits related to biotic and abiotic stresses and also fruit quality traits. However, wild species remain largely unexploited for brinjal breeding compared to other crops like tomato. The experiment was conducted with 10 locally collected cultivated brinjal crossed with three wild relatives (*Solanum tovum*, *S. nigrum* and *S. sisymbriifolium* Lam) in field of Plant Genetic Resources Centre, BARI, Joydebpur Gazipur. Wild relatives of eggplants represent a good source of variation for breeding programmes, in particular for traits related to biotic and abiotic stresses and also fruit quality traits. However, wild species remain largely unexploited for brinjal breeding compared to other crops like tomato. Seven cultivated brinjal accessions (SM001-02, SM001-04, SM001-06, SM001-07, SA002-02, SA002-03 and SMA003-03) were crossed with three wild accessions (ST004-03, San005-01 (*Solanum anguivi*) and SA002-08 (*Solanum aethiopicum*)) in an open field using completely randomized design. The success of fruit and seed set as well as seed germination depended on the cross combination and the direction of the cross. In this regard, no fruit set was recorded when the wild accessions were used as female parents. The highest fruit set and mean number of seeds/fruits was obtained from the crosses Sm001-07×ST004-03 (6%; 264 seeds) and Sm001-07 × San005-01 (5.7%, 114 seeds), respectively. The germination of hybrid seeds was recorded in only three crosses, SM001-07 × ST004-03, SM001-07 × San005-01 and SA002-02 × San005-01 with germination range from 3.3 to 16.6%. However, plantlets from these seeds did not survive after two weeks of germination. The hybridity of the putative interspecific F1 hybrids (through tissue culture) was confirmed with a morphological marker. These hybrids obtained will contribute to broadening the genetic background of cultivated brinjal species used in this study and to the genetic enhancement of this crop

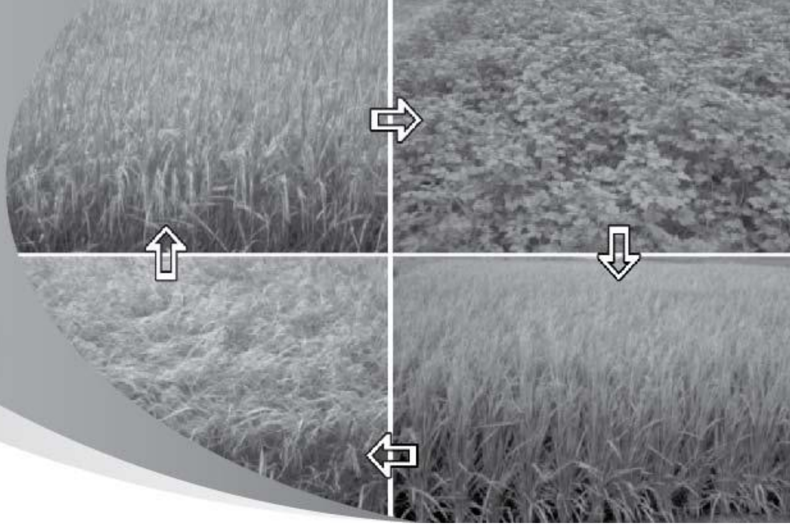
Development of mobile applications for pgr passport information collection

Passport data collection is one of the prioritized works of PGRC, BARI. PGR Scientist collect data manually with a pre-defined paper based form and there about least 33 columns. After collecting data, input the data in MS Excel, which is very much time consuming and cumbersome. At the present edge of ICT; Mobile Apps is the powerful system to input data systematically, quickly and errorless. the present investigation was undertaken to develop a mobile application for electronic passport data collection of PGR that runs on consumer grade Android mobile phone. An android based ***BARI PGR Passport App*** was developed to collect PGR passport information, which has strong footprint in arena of PGR database with the existing ***Gene Bank Management system*** get extra acceleration. To the best of our knowledge, this is the first mobile application that can assist researchers and users with the PGR passport data collection.

Data base development and data entry for germplasm documentation

Three thousand six hundred ten passport information of germplasm were recorded for documentation during 2019-20. The documentation of conservation, characterization and distribution information has been in progress. The proper documentation of plant genetic resources is required to properly conserve, manage and use biodiversity. For information of germplasm documentation is important for the researcher. PGRC/BARI has been created a new database information software with a powerful, flexible, easy-to-use of the information of plant genetic resource (PGR). The study has been started since October 2017-18. A core set of web services, will update data stored locally and enable third party data sharing. Open-source programming tools MySQL has been adopted for data entry and editing forms. The impact of system use will be evaluated by users during and following database implementation and utilization.

14 ON-FARM STUDIES



A. Cropping Pattern

Development of four crop-based alternate cropping pattern against farmer's cropping pattern in different locations of Bangladesh

A set of four crop-based alternate cropping pattern (ACP) were tested against farmers existing two or three crop-based cropping pattern (FCP) at farmer's field condition in different FSRD and MLT sites under On-Farm Research Division funded by Ministry of Agriculture, The People's Republic of Bangladesh. These trials were conducted during the year of 2017-18 and 2019-20 to develop four crop-based cropping pattern to increase the cropping intensity and productivity for the respective location. In all location, ACP consist of 4 crops were compared with FCP those belong to 2/3 crops. In most cases, the results showed that the ACP with four crops could be established successfully with short duration crop varieties. In these studie, ACP was more profitable and viable than those of FCP in terms of agronomic and economic point of view. Irrespective of locations, rice equivalent yield (REY), crop productivity, land use efficiency and profitability were higher in ACP than those of FCP. Inclusion of new crops in the existing cropping pattern and replacing old and traditional varieties by modern varieties enhanced productivity and profitability.

Development of wheat-grain legume-T. Aman rice cropping pattern against wheat-fallow-T. Aman rice in barind area

The experiment was conducted at farmers' field of MLT site, Sapahar, Naogaon during the year of 2017-18 and 2018-19 to study productivity, production efficiency, land use efficiency and economic return of some cropping pattern in High Barind Tract. There were three cropping pattern in the study i.e., two improved cropping patters over existing Wheat-Fallow-T. Aman rice. The improved cropping patterns were Wheat-Mungbean-T. Aman rice and Wheat-Blackgram-T. Aman rice. The experiment was conducted with randomized complete block design with six dispersed replications. The maximum rice equivalent yield was obtained from Wheat-Mungbean-T. Aman rice pattern. However, Wheat-Mungbean-T. Aman rice cropping pattern resulted in higher variable cost; nevertheless, it gave the highest values of gross return, gross margin, marginal benefit-cost ratio and production efficiency. This cropping pattern gave on an average 32-35% higher rice equivalent yield (REY) compared to the existing Wheat-Fallow-T. Aman rice pattern.

Development of lentil-sesame-T. Aman rice cropping pattern against wheat-fallow-T. Aman rice in barind area

The experiment was made at farmers' field of MLT site, Amnura, Chapainawabgonj during the year of 2017-18 and 2018-19 to study productivity, production efficiency, land use efficiency and economic return of some cropping patterns in High Barind Tract. Two cropping patterns i.e., Lentil-Sesame-T. Aman rice and Wheat-Fallow-T. Aman rice (check) was in this trial. The experiment was conducted with randomized complete block design with six dispersed replications. Higher rice equivalent yield was obtained from Lentil-Sesame-T. Aman rice pattern. However, Lentil-Sesame-T. Aman rice cropping pattern resulted in higher variable cost; nevertheless, it gave the highest values gross return, gross margin, benefit-cost ratio and production efficiency. This cropping pattern gave on an average 26-54% higher system rice equivalent yield (REY) compared to the existing Wheat-Fallow-T. Aman rice pattern.

Development of productive cropping pattern in Bhola

The study was executed at Bhola Sadar during the year of 2019-20 under AEZ-18 to introduce maize and mungbean into existing pattern for increasing cropping intensity. Two alternate cropping patterns *viz*; CP-1:Potato (BARI Alu-37)/Maize (BARI Hybrid Bhutta-9)-T.Aman rice (BRRI dhan52) and CP-2:Potato (BARI Alu-37)-Mungbean (BARI Mung-6)-T. Aman rice (BRRIdhan52) were tested against existing cropping pattern Potato (Diamant)-Fallow-T.Aman (Moulata) patter in three farmers field considering as three replications. T. Aman rice BRRI dhan52 gave 23% higher yield than local variety. The highest rice equivalent yield (43.0 t ha^{-1}) was obtained from CP-1: Potato/Maize-T.Aman cropping pattern followed by CP-2: Potato-Mungbean-T. Aman (34.0 t ha^{-1}) which was 43% and 28% higher, respectively over existing pattern (24.2 t ha^{-1}). In CP-1: Potato/Maize-T.Aman cropping pattern gross margin (Tk. 265400 ha^{-1}) was higher followed by CP-2: Potato-Mungbean-T. Aman cropping pattern (Tk. 240200 ha^{-1}) than existing farmer’s pattern Potato-Fallow-T. Aman (Tk.110100). The highest MBCR (8.83) was observed from CP-2: Potato-Mungbean-T. Aman cropping pattern and the lowest MBCR (2.23) was found from CP-1: Potato/Maize-T.Aman cropping pattern.

Development of alternate cropping pattern proso millet-fallow-T. Aman and safflower-fallow-T. Aman against existing fallow-fallow-T. Aman cropping pattern in saline char area

The experiment was conducted to evaluate the agro-economic performance of alternate (Proso Millet-Fallow-T. Aman and Safflower-Fallow-T. Aman) cropping patterns against farmer’s existing cropping pattern (Fallow- Fallow-T. Aman) for increasing cropping intensity and productivity at six (three for each alternate cropping pattern) farmers’ field of FSRD site, Subarnachar upazila under Noakhali district during the year of 2019-2020. During the *rabi* season one crop could be grown successfully in the fallow land by using suitable salinity tolerance or escaping crops which was tested in the alternate cropping pattern (ACP). The highest rice equivalent yield (7.76 tha^{-1}) was obtained from Safflower-Fallow-T. Aman (ACP2) cropping pattern. Gross return of that pattern was Tk.153300 ha^{-1} which was 4.47 and above 200% higher over Proso millet-Fallow-T. Aman and farmers’ existing cropping patterns. The higher gross margin from ACP2 pattern was archived mainly higher price of the component crop.

Development of alternate cropping pattern sweet sorghum-fallow-T. Aman against existing fallow-fallow-T. Aman cropping pattern in saline char area

The experiment was conducted to evaluate the agro-economic performance of alternate (Sweet Sorghum-Fallow-T. Aman) cropping patterns against farmers existing cropping pattern (Fallow-Fallow-T. Aman) for increasing cropping intensity and productivity at three farmers’ field of Kellar Char, Companiganj upazila under Noakhali district during the year of 2019-20. During the Rabi season one crop could be grown successfully in the fallow saline land by using suitable salinity tolerance which was tested in the alternate cropping pattern (ACP). The highest rice equivalent yield (6.49 t ha^{-1}) was obtained from Sweet Sorghum-Fallow-T. Aman alternate cropping pattern. Gross margin of that pattern was Tk.47177 ha^{-1} which was above 150% higher over farmers’ existing cropping pattern.

Development of alternate cropping pattern mustard-mungbean-T. Aman rice against mustard-fallow-T. Aman rice cropping pattern under AEZ 19

A field experiment was conducted at the farmers' field of Aksina, Kosba, Brahmanbaria under AEZ 19 during the year of 2018-19 to fit Mungbean in the existing cropping pattern and also to increase cropping intensity and productivity. Two treatments i.e, T_1: Existing cropping pattern (Mustard -Fallow-T. Aman) and T_2: Alternate cropping pattern (Mustard- Mungbean- T. Aman) was studied. From the research findings, it is documented that Rice equivalent yield (REY) in alternate cropping pattern is 17.13 t ha^{-1}, which is almost 140 % higher over existing pattern (7.12 t ha^{-1}). Higher gross return (Tk. 256950.00 ha^{-1}) and gross margin (Tk. 141570.00 ha^{-1}) as well as higher BCR (2.23) were also obtained from alternate cropping pattern over existing cropping pattern due to additional yield of Mungbean and higher yield of modern variety BARI Sarisha-14 and BRRI dhan71.

Development of alternate cropping pattern maize-T. Aus- T. Aman against boro-fallow-T. Aman

The trial was conducted in the farmers' field of Multilocation Testing site, Kaliganj, Jhenidah during the year of 2019-20 to develop an alternate cropping pattern Maize (BHM-9)-T. Aus (BRRI dhan48)-T. Aman rice (BRRI dhan75) against Boro (BRRI dhan28)-Fallow-T. Aman rice (Binadhan-7). There were two treatments i. e, T_1: Existing cropping pattern: Boro (BRRI dhan28)-Fallow-T. Aman (Binadhan-7) and T_2: Alternate cropping pattern: Maize (BHM-9)-T. Aus (BRRI dhan48)-T. Aman (BRRI dhan75). Higher Rice Equivalent yield and gross margin were obtained from alternate cropping pattern over existing cropping pattern due to inclusion of new crops and marginal benefit cost ratio was 3.46.

Development of alternate cropping pattern through gardenpea-boro- T. Aman against fallow- boro- T. Aman

The experiment was conducted at the MLT site, Satkhira during the year of 2017-'18, 2018-'19 and 2019-'20 in order to improve the productivity and profitability of existing cropping pattern Fallow - Boro- T. Aman by introducing garden pea variety after T. Aman harvest. Results revealed that improved cropping pattern Garden pea - Boro- T. Aman produced highest total rice equivalent yield (26.51 t ha^{-1}) than farmers practice (10.74 t ha^{-1}). At the same time improved cropping pattern gave highest gross return (Tk. 526,011 ha^{-1}) and gross margin (Tk. 261422 ha^{-1}). The improved pattern also gave higher MBCR over existing pattern.

Development of maize-kenaf-fallow cropping pattern against existing fallow-boro- fallow cropping pattern in upper catena of haor area

An attempt was taken to transform Fallow-Boro rice-Fallow cropping pattern into Maize-Kenaf-Fallow to develop two crops-based cropping patterns for upper catena of haor areas and its agro-economic performance through modern variety and improved technology. With the inclusion of maize and kenaf against rice-based pattern was compared in farmers' field at haor region of Kishoreganj during the year of 2019-20. The inclusion of maize and kenaf against boro rice increased the rice equivalent yield (REY) 68% with farmers' existing pattern. The gross return was increased by 68% in Maize-Kenaf-Fallow sequences compared to existing Fallow-Boro-Fallow 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 the maize and kenaf cropping sequence with the inclusion of high yielding varieties.

Improvement of existing fallow-boro rice cropping pattern through mustard and potato in haor area of Kishoreganj

The study was executed at Nunir haor under the MLT site Nikli, Kishoreganj during the year of 2019-20 to introduce potato and mustard before boro rice as well as to identify the feasible and profitable cropping pattern against the sole boro rice cultivation in the haor areas of Kishoreganj. Two patterns viz; potato-boro- fallow and mustard-boro-fallow were tested to sole rice production followed by RCB design with four dispersed replications. The highest rice equivalent yield of potato - boro - fallow cropping pattern was found 23.01 t ha^{-1}, which was 197.28% higher than the sole boro rice cultivation and 78.79% higher than the mustard - boro - fallow cropping pattern. The highest gross margin was obtained from potato - boro - fallow cropping pattern Tk. 220200 ha^{-1} and MBCR 3.22 followed by mustard- boro- fallow cropping pattern Tk. 119600 ha^{-1} and 1.75 respectively.

Development of black gram-boro -fallow cropping pattern against fallow-boro-fallow cropping pattern in haor area

The study was executed at Nunir haor under the MLT site Nikli, Kishoreganj during the year of 2019-2020 to introduce black gram before boro rice as well as to identify the feasible and profitable cropping pattern against the sole boro rice cultivation in the haor areas of Kishoreganj. The patterns blackgram – boro - fallow was tested to sole rice production followed by RCB design with three dispersed replications. The highest whole pattern rice equivalent yield (8.87 t ha^{-1}) was found from black gram - boro - fallow cropping pattern which was 16.55% more than the sole boro plantation. The utmost whole pattern gross margin Tk. 100300 ha^{-1} and MBCR 1.50 were obtained from black gram - boro - fallow cropping pattern.

Development alternate cropping pattern vegetable-boro-T. Aman Rice against vegetable-fallow - T. Aman

The experiment was conducted at OFRD, BARI, Shibpur, Narsingdi during the year of 2018-19 to improve the existing cropping pattern by inclusion of vegetable and to increase crop yield and farmers income. The experiment was laid out in 4800 m^2 of land under 6 farmers. Alternate cropping pattern Cauliflower (Var. 770) - Boro (BRRI dhan50) - T. Aman (BRRI dhan57) gave higher whole pattern gross margin (Tk. 123890 ha^{-1}) against the existing pattern Vegetable (White snow)- Fallow-T. Aman (BRRI dhan39) (Tk. 101430 ha^{-1}).

Study on vegetable based cropping pattern in Narsingdi

A field experiment was conducted at OFRD, BARI, Shibpur, Narsingdi during the year of 2017-18 and 2018-19 to study an economically profitable vegetable-based cropping pattern in Narsingdi region for increasing cropping intensity and productivity as well as to meet the vegetable demand for farm family as well as the country. The studied vegetable-based cropping patterns were CP1: Radish-Cauliflower-Stem amaranth-Indian spinach-Red amaranth, CP2: Red amaranth-Cauliflower-Ladies finger-Brinjal and CP3: Bottle Gourd-Snack gourd-Country Bean-Cucumber respectively. The results showed that five vegetable crops could successfully be grown one after another in a sequence in the farmer's field instead of two or three crops in a pattern. Study revealed that the highest Bottle gourd equivalent yield (BEY) 158.34 t ha^{-1} yr^{-1} was obtained from five vegetable crop based cropping pattern CP3: Bottle gourd-Snack gourd-Country bean-Cucumber, the second highest cauliflower equivalent yield (CEY) (124.13 t ha^{-1} yr^{-1}) CP1: Radish-Cauliflower-Stem amaranth-Indian spinach-Red amaranth whereas the lowest CEY (120.65 t ha^{-1} yr^{-1}) CP2: Red amaranth –Cauliflower-Ladies finger-Brinjal was documented in cropping pattern during one year crops cycle. From the economic analysis, it was observed that the highest gross return Tk. 1583400 ha^{-1} was obtained from vegetable crop-based cropping pattern CP3: Bottle Gourd-Snack gourd-Country Bean-Cucumber which leads to the highest gross margin (Tk.1308400 ha^{-1}) as well as the highest MBCR (5.76)

Development of alternate cropping pattern foxtail millet-fallow-T. Aman against farmers existing pattern fallow-fallow-T. Aman in coastal area of Bangladesh

An experiment was conducted at MLT site, Amtali, Borguna during the year of 2019-20. Alternate cropping pattern Foxtail Millet-Fallow-T. Aman was tested against farmers' existing pattern Fallow-Fallow-T. Aman. Foxtail millet-Fallow-T. Aman pattern gave 82% higher rice equivalent yield over existing pattern. The pattern also gave higher gross return (Tk. 116660 ha^{-1}).

Development of alternate cropping pattern sunflower– T. Aus rice -T. Aman rice against farmers existing pattern relay cowpea – fallow - T. Aman rice

The experiment was conducted at Kalapara, Patuakhali during the year of 2019-20 to determine the profitability of the alternate cropping pattern Sunflower (BARI Surjomukhi-2)- T. Aus (BRRI dhan48) - T. Aman rice (BRRI dhan39) against the farmers' existing pattern Cowpea (BARI Felon-1) - Fallow - T. Aman rice (Sarnogota). The alternate cropping pattern found agro-economically more profitable than the existing pattern. The highest gross return (Tk. 278500 ha^{-1}), gross margin (Tk. 119350 ha^{-1}) and MBCR (2.20) were obtained from alternate cropping pattern over existing pattern.

Development of alternate wheat-mungbean-T. Aman rice cropping pattern against existing wheat-fallow- T. Aman rice

The experiment was conducted at Kazirchar, Sherpur Sadar, Sherpur during the year of 2017-18 and 2018-19 to determine the agro-economic performance of Wheat-Mungbean-T. Aman against existing Wheat-Fallow-T. Aman rice cropping pattern through incorporation of modern high yielding varieties and improved management practices. The result revealed that the improved cropping pattern produced the higher rice equivalent yield (13.65 t ha^{-1} yr^{-1}) and (13.27 t ha^{-1} yr^{-1}) over existing pattern (7.51 t ha^{-1} yr^{-1}) and (8.52 t ha^{-1} yr^{-1}) in 2017-18 and 2018-19, respectively. Gross return and gross margin of the improved pattern in 2018-19 were found Tk. 2,36,490 ha^{-1} and Tk. 1,37,065 ha^{-1}, respectively. Whereas, in 2018-19 recorded Tk. 256150 ha^{-1} and Tk.1457337 ha^{-1}, respectively which was higher than existing pattern both the year. The marginal benefit cost ratio (MBCR) was found 2.73 in 2019-20 and 2.83 in 2018-19.

Development of alternate cropping pattern lentil-maize-T. Aman against the existing lentil-jute-T aman rice cropping pattern

The experiment was conducted at farmers' field of Baruipara, under MLT site, Paba, Rajshahi during the year of 2018-19 to study productivity, profitability and agro-economics of lentil based alternate cropping pattern (AP: Lentil-Maize-T Aman) over the existing Lentil- Jute-T. Aman cropping pattern in High Ganges River Floodplain (AEZ 11). The experiment was conducted with randomized complete block design with six dispersed replications. First year's crop cycle was completed for generating data regarding performance among the cropping patterns. Although, difference was found in component crops yield, additional inclusion of maize in the existing cropping pattern increased the system productivity as well as economic return. Higher rice equivalent yield (22.79 t ha^{-1}) was recorded from maize crop included alternate cropping pattern (AP: Lentil-Maize-T Aman) over the existing (EP: Lentil-Jute-T Aman) cropping pattern (21.67 t ha^{-1}). The Production efficiency (PE) was observed maximum in AP: Lentil-Maize-T Aman rice (71.89 kg ha^{-1} day^{-1}) than EP. The higher LUE (91.78%) was recorded in EP: Lentil-Jute-T Aman rice followed by AP: Lentil-Maize-T Aman (86.85%).The AP: Lentil-Maize-T Aman rice had a maximum gross return (Tk. 370412 ha^{-1}) along with a lower cultivation cost (Tk. 216939 ha^{-1}), which also contributed to higher gross margin (Tk. 153473 ha^{-1}) and BCR (1.71) than EP. The maximum profitability (Tk. 420.47 $ha^{-1}day^{-1}$) was obtained in AP than EP (Tk. 371.24 $ha^{-1}day^{-1}$).

Development of alternate cropping pattern garlic/brinjal-T. Aman against the existing garlic-maize-T aman rice cropping pattern

The experiment was conducted at farmers' field of Shibpur MLT site, Puthia, Rajshahi during the year of 2018-19 to study productivity, profitability and agro-economics of garlic based alternate cropping pattern (AP: Garlic/Brinjal-T Aman) over the existing Garlic-Maize-T. Aman cropping pattern in High Ganges River Floodplain (AEZ 11). The experiment was conducted with randomized complete block design with six dispersed replications. First year's crop cycle was completed for generating data regarding performance among the cropping patterns. Although, difference was found in component crops yield, additional inclusion of Brinjal in the existing cropping pattern increased the system productivity as well as economic return. Higher rice equivalent yield (87.32 t ha^{-1}) was recorded from Brinjal crop included alternate cropping pattern (AP: Garlic/Brinjal-T Aman) over the existing (EP: Garlic-Maize-T. Aman) cropping pattern (58.50 t ha^{-1}).The Production efficiency (PE) was observed maximum in AP: Garlic/Brinjal-T. Aman rice (276.33 kg^{-1} ha^{-1} day^{-1})than EP. The higher LUE (93.15 %) was recorded in EP: Garlic-Maize-T. Aman rice followed by AP: Garlic/Brinjal- T Aman (86.58%).The AP: Garlic/Brinjal-T Aman rice had a maximum gross return (Tk. 1402484 ha^{-1}) along with a higher cultivation cost (Tk. 480369 ha^{-1}), which also contributed to higher gross margin (Tk. 922115 ha^{-1}) and BCR (2.92) than EP. The maximum profitability (Tk. 2526.34 $ha^{-1}day^{-1}$) was obtained in AP than EP (Tk. 1511.81 ha^{-} day^{-1}).

Development of alternate cropping pattern T. Aman rice mustard- onion / maize against T. Aman rice -fallow- onion / maize

A field trial was conducted at the farmers' field of Paba, Rajshahi during the year of 2018-19 to develop T. Aman ric-Mustard-Onion-Maize cropping pattern against T. Aman rice-Fallow-Onion-Maize cropping pattern. There were two treatments i.e. T_1: Existing Cropping pattern: T. Aman (local, Sarna)-Fallow- Onion (Taherpuri)-Maize (NK 40) and T_2: Alternate Cropping pattern:

T. Aman (BRRI dhan75) – Mustard (BARI Sarisha-14)-Onion (BARI Piaj-4) -Maize (Laltir 339). Higher rice equivalent yield (28.52 t ha^{-1}) and gross margin (319015 Tk ha^{-1}) were obtained from alternate cropping pattern over existing cropping pattern due to introduction of new crop (mustard) and new varieties (BRRI dhan75, BARI Piaj-4 and Maize Laltir 339).

Development of alternate cropping pattern potato-boro T. aus-T. Aman against potato – boro-T. Aman

A field trial was conducted at the farmers' field of Mohanpur, Rajshahi during the year of 2018-19 and 2019-20 to develop Potato-Boro-T. Aus-T. Aman rice cropping pattern against Potato-Boro-T. Aman rice cropping pattern. There were two treatments i.e, T_1: Existing Cropping pattern: Potato (BARI Alu-7)-Boro (BRRI dhan28)-T.Aman (Local, Sarna) and T_2: Alternate Cropping pattern: Potato (BARI Alu-37)-Boro (BRRI dhan84)-T.Aus (BRRI dhan82).)-T.Aman (BRRI dhan75). Higher rice equivalent yield was obtained 29.96 and 29.95 t ha^{-1} in the year of 2018-19 and 2019-20, respectively from alternate cropping pattern over existing cropping pattern due to introduction of new crop and varieties. Similarly, gross margins were obtained higher in the alternate cropping pattern over existing cropping pattern in the two consecutive years.

Development of alternate cropping pattern mustard-mungbean-T. Aman rice against mustard-fallow-T. Aman rice cropping pattern under AEZ 20 & 22

An experiment was executed at multilocation testing (MLT) site, Madhapur, initiated in the years of 2016-19 to see the performance of improved cropping pattern and to increase the productivity and income of farmer. The experimental design was RCB with six (6) dispersed replications. The existing and improved cropping patterns were Mustard-Fallow-T. Aman (CP_1: Existing cropping patter) and Mustard-Mung bean-T. Aman rice (CP_2: Improved cropping pattern), respectively. BARI Sarisha-14 of mustard and BARI Mung bean-6 of mung bean was used and BRRI dhan57 of T. Aman rice was used in this trial. The highest rice equivalent yield 8.23 t ha^{-1} was recorded from CP_2 compared to CP_1 (5.04 t ha^{-1}; which was almost 63.29% higher than that of existing pattern CP_1.

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) sites, Moulvibazar during the years of 2016-19 to see the performance of improved cropping pattern and to increase the productivity and income of the farmers. The experimental design was RCB with six (6) dispersed replications. The existing and improved cropping patterns were Fallow-T. Aus-T. Aman (CP_1: Existing cropping patter) and Mustard-T. Aus-T. Aman rice (CP_2: Improvement cropping pattern), respectively. BRRI dhan65 of T. Aus rice and BRRI dhan57 of T. Aman rice were used in this trial. The improved pattern CP_2 provided 9.37 t ha^{-1} of T. Aman rice equivalent yield which was almost 45.00% higher than that of existing pattern $CP_{1.}$

Development of alternate cropping pattern mustard-boro-T. Aus-T. Aman rice against mustard-boro-T. Aman rice cropping pattern

An on-farm trial on four crops patter was conducted under the MLT Site, Sariakandi Bogura during the year of 2019-20 with a view to developing Mustard-Boro-T. Aus-T. Aman rice base four crops pattern against Mustard-Boro-T. Aman rice-based three crops one. Varieties were used for the Existing Cropping pattern (Mustard (Tory-7)-Boro (BRRI dhan28)-T. Aman (Swarna) and for Alternate Cropping pattern (Mustard (BARI Sarisha-14)-Boro (BRRI dhan28)-T. Aus (BRRI dhan48)-T. Aman (BRRI dhan57). Higher rice equivalent yield (18.19 tha^{-1}) and gross margin (Tk. 197772 ha^{-1}) were obtained from the four crops pattern over the three crops pattern (rice equivalent yield, 14.06 $tha^{-1,}$ and gross margin, Tk 163902 ha^{-1}) during the year cycle which together contributed to the higher marginal return Tk. 82425 ha^{-1} and marginal benefit-cost ratio of 1.70 against the marginal cost of Tk. 48555 ha^{-1} over the three crops pattern.

Development of alternate cropping pattern potato/sweet gourd-T. Aus-T. Aman rice against potato-boro-T. Aman rice cropping pattern

An on-farm trial on four crops patter was conducted under the MLT Site, Sonatola Bogura during the year of 2019-20 cropping season with a view of developing Potato/Sweet gourd-T. Aus-T.

Aman rice-based four crops pattern against Potato-Boro-T. Aman rice-based three crops one. Varieties were used for Alternate Cropping pattern; Potato (BARI Alu-41)/Sweet gourd (BARI F_1 Mistikumra-1)-T. Aus (BRRI dhan48)-T. Aman (BRRI dhan71) and for Existing Cropping pattern; Potato (Lalpakri)-Boro (BRRI dhan28)-T. Aman (Swarna). Higher rice equivalent yield (31.67 t ha^{-1}) and gross margin (Tk. 399932 ha^{-1}) were obtained from the four crops pattern over the three crops pattern (rice equivalent yield, 21.80 t ha^{-1}, and gross margin, Tk 266700 ha^{-1}) during the year cycle which together contributed to the higher marginal return Tk. 197260 ha^{-1} and marginal benefit-cost ratio of 3.08 against the marginal cost of Tk. 64028 ha^{-1} over the three crops pattern

Development of alternate cropping pattern tomato-T.aus-T. Aman rice against tomato-fallow-T. Aman rice

An experiment was carried out at the MLT site, Ranigonj sader Dinajpur during rabi season of 2018-19 to develop an economically sustainable and profitable cropping pattern over existing pattern. Development of alternate cropping patterns Tomato-T. Aus-T. Aman, was introduced against the existing cropping pattern Tomato–Fallow–T. Aman rice. The experiment was carried out in RCB design with three dispersed replications. Grain yield of rice, Fruits of tomato were satisfactory. The highest rice equivalent yield was obtained from the alternate cropping pattern Tomato-T. Aus rice-T. Aman rice. The gross return and gross margin were higher in the alternate cropping patterns compared to existing cropping pattern due to additional yield of T. Aus rice. So, crop cultivation in alternate cropping pattern would help to increase total production, farmer’s income, employment opportunity and livelihood improvement

Development of potato-boro-yard long bean-T.aman cropping pattern agains T.potato-boro-T.aman cropping pattern in mymensingh region

An attempt was taken to transform Potato-Boro-T.aman cropping pattern into Potato-Boro-Yard long bean-T.aman to determine the agro-economic performance through modern variety and improved technology. With the inclusion of yard long bean in potato-rice based pattern was compared in farmers’ field at Gouripur region of Mymensingh district during 2017-18 and 2018-19. After two years study period, the inclusion of yard long bean in between potato-rice pattern increased the rice equivalent yield (REY) 55% with farmers’ existing pattern. The gross return was increased by 53% in Potato-Boro-Yard long bean-T.aman rice sequences compared to existing Potato-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 the Potato-rice cropping sequence with the inclusion of high yielding yard long bean variety.

B. Intercropping

Intercropping of bushbean with maize in hill valleys of Bandarban

A field experiment was conducted to evaluate the suitability and economic performance of BARI Bushbean intercrop with BARI Hybrid Maize at farmer’s field of hill valleys in Bandarban during the rabi season of 2019-20. Two treatments *viz*. T_1: Sole Maize and T_2: Maize + Bushbean were used for the experiment. The results revealed that Maize-Bushbean combination did not influence yield and yield contributing characters of maize as compared to sole maize. The intercropping combination performed better in terms of maize equivalent yield, gross return and benefit cost ratio (BCR) over sole crops.

Intercropping of cabbage with Bt. Brinjal

An experiment was carried out at MLT site Tularampur, Narail during the year of 2019-20. Four treatments *viz*. T_1= 1 row cabbage between 2 rows of Brinjal, T_2= 2 row cabbage between 2 rows of Brinjal, T_3= 1cabbage between 2 Brinjal plant and T_4= Sole Brinjal were used in the experiment. The experiment was laid out in RCB with 3 replications. Cabbage (Atlas-70) was intercropped with Bt begun. Yield and yield contributing characters of Bt begun showed no significant difference due to intercropping. The highest Bt begun yield (29.45 tha-1) was produced from T_4 (Sole Brinjal) followed by T_1 (1 row cabbage between 2 rows of Brinjal) and T_2 (2 row cabbage between 2 rows of Brinjal) and this was lowest

(27.97 t ha^{-1}) from T_3 (1cabbage between 2 Brinjal plant). The highest equivalent yield (50.10 t ha^{-1}) of Bt begun was obtained from T_2 and this was lowest (29.45 t ha^{-1}) from T_4. The highest gross margin (1278000 Tk. ha^{-1}) and benefit cost ratio (6.68) was found from T_2 (2 row cabbage between 2 rows of Brinjal). and the lowest gross margin (Tk. 673500 ha^{-1}) and benefit cost ratio (4.21) was found from T_4 (Sole Bt brinjal).

Intercropping of spinach with Bt. Brinjal

An experiment was carried out at MLT site Tularampur, Narail during the year of 2019-20. Four treatments viz. T_1= 1 row spinach between 2 rows of Brinjal, T_2= 2 row spinach between 2 rows of Brinjal and T_3= Sole Brinjal were used in the experiment. The experiment was laid out in RCB with 3 replications. Spinach was intercropped with Bt Brinjal. Yield and yield contributing characters of Bt Brinjal showed no significant difference due to intercropping (Table 1). The highest Bt Brinjal yield (26.98 t ha-1) was produced from T_3 followed by T_1 and this was lowest (25.47 t ha^{-1}) from T_2. The highest equivalent yield (28.76 t ha^{-1}) of Bt Brinjal was obtained from T_2 and this was lowest (26.78 t ha^{-1}) from T_3. The highest gross margin (Tk. 642800 ha^{-1}) and benefit cost ratio (3.92) was found from T_2 and the lowest gross margin (Tk. 593400 ha^{-1}) and benefit cost ratio (3.70) was found from T_3.

Intercropping of mungbean with banana

An experiment was carried out at Jhikargacha MLT site, Jashore during the year of 2017-18, 2018-19 and 2019-20 to evaluate the performance of mungbean intercropping with banana. Four treatments *viz*., T_1= Sole banana (2m x 2m), T_2= 4 rows of mungbean in between 2 rows of banana, T_3= 6 rows of mungbean in between 2 rows of banana and T_4= Broadcast of mungbean in between 2 rows of banana were used in the experiment. The experiment was laid out in RCB with 6 replications. Yield and yield contributing characters of mungbean were influenced significantly due to intercropping. The highest mungbean yield (1.48 t ha^{-1}) was produced from T_3 (6 rows of mungbean in between 2 rows of banana) followed by T_2 (4 rows of mungbean in between 2 rows of banana) and the lowest was (1.28 t ha^{-1}) from T_4 (Broadcast of mungbean in between 2 rows of banana). The highest gross margin (581990 Tk. ha^{-1}) and benefit cost ratio (3.72) was found from T_3 (6 rows of mungbean in between 2 rows of banana). The lowest gross margin (Tk. 503030 ha^{-1}) and benefit cost ratio (3.45) was found from T_1 (Sole banana).

Intercropping of mungbean with papaya

An experiment was carried out at Jhikargacha MLT site, Jashore during the year of 2017-18, 2018-19 and 2019-20 to evaluate the performance of mungbean intercropping with banana. Four treatments viz. T_1= Sole papaya (2m x 2m), T_2= 4 rows of mungbean in between 2 rows of papaya, T_3= 6 rows of mungbean in between 2 rows of papaya and T_4= Broadcast of mungbean in between 2 rows of papaya were used in the experiment. The experiment was laid out in RCB with 6 replications. Yield and yield contributing characters of mungbean were influenced significantly due to intercropping. The highest mungbean yield (1.49 t ha^{-1}) was produced from T_3 (6 rows of mungbean in between 2 rows of papaya) followed by T_4 (broadcast of mungbean in between 2 rows of papaya) and this was lowest from T_2 (4 rows of mungbean in between 2 rows of papaya). The highest gross margin (Tk. 579740 ha^{-1}) and benefit cost ratio (3.25) was found from T_3 (6 rows of mungbean in between 2 rows of papaya). The lowest gross margin (Tk. 504360 ha^{-1}) and benefit cost ratio (3.01) was found from T_1 (Sole papaya).

Intercropping of vegetable with chilli in southern region of Bangladesh

A field experiment on intercropping of vegetables with chilli was executed at saline area of Kuakata in Patuakhali district during the *robi* season of 2019-20 to find out an appropriate crop to cultivation with chilli for higher productivity and maximum economic return. The trial was consisted of four crop combinations viz., T_1: Sole chilli, T_2: chilli + Kangkong, T_3: chilli + Indian Spinach, T_4: chilli + Coriander. The highest yield (dry chilli) was obtained from sole chilli (2.05 t ha-^{1}). Among the intercropping treatments, the highest chilli dry yield (1.87 t ha^{-1}) was obtained from chilli + Indian spinach. The same combination was also higher gross margin (Tk. 273000 ha^{-1}) and BCR (3.00).

Intercropping of short duration vegetables with sweet potato in Sylhet region

A field experiment was laid out during the year of 2019-20 in winter season at Kamalbazar, South surma, Sylhet.Five different intercropping combinations, T_1 = Sweet Potato + Red Amaranth T_2; = Sweet Potato + Leaf Amaranth; T_3 = Sweet Potato + Mustard Green; T_4 = Sweet Potato + Mustard and T_5 = Sweet Potato sole were considered. Highest sweet potato equivalent yield (41.75 t ha^{-1}) was obtained from the treatment T_3 = (Sweet Potato + Mustard green) whereas the lowest yield (30.60 t ha^{-1}) was found from the treatment T_5 = (Sweet Potato sole). The highest gross return (Tk. 6,25,950 ha^{-1}) and gross margin (Tk. 4,95,500 ha^{-1}) was obtained from the treatment T_3 (Sweet Potato + Mustard green). Whereas, the lowest gross return (Tk. 459000 ha^{-1}) and gross margin (Tk. 3,30,3000 ha^{-1}) was obtained from the treatment T_5 (Sweet Potato sole).

Intercropping of brinjal with amaranth, mustard green and coriander in Sylhet region

An experiment was conducted at multi location testing (MLT) site, Moulvibazar during two consecutive years of 2018-19 and 2019-20 to find out the suitable crop combination for increasing total productivity, return and maximize land utilization through intercropping system. Five treatments *viz*., Brinjal 100% + Red amaranth 100%, Brinjal 100% + Leaf amaranth 100%, Brinjal 100% + Coriander 100%, Brinjal 100% + Mustard green 100% and sole of base crops (Brinjal) were used in the study. Results showed that different intercropping combination did not influence yield and yield contributing characters of Brinjal. All the intercropping combinations were performed better in terms of Brinjal equivalent yield, gross return and benefit cost ratio (BCR) over sole crops. Among the intercropping combinations, Brinjal 100% (100 cm × 70 cm) + Mustard green 100% was the most feasible and profitable intercropping system in respect of Brinjal equivalent yield (32.94 t ha^{-1}), gross return (Tk.498100 ha^{-1}), gross margin (Tk.341800 ha^{-1}) and benefit cost ratio (3.24).

Intercropping of mukhikachu and papaya with pineapple

A field experiment was conducted at the MLT site Modhupur, Tangail during the *rabi* season of 2015-17 and 2018-20 under AEZ-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= Pineapple (100%), T_2= Pineapple (100%) + Mukhikachu (40%), T_3= Pineapple (100%) + Papaya (66%) and T_4= Pineapple (100%) + Papaya (66%) + Mukhikachu (40%) were consider. The average highest pineapple equivalent yield of two consecutive crop cycle (59 t ha^{-1}) was recorded from the treatment T_4 (Pineapple (100%) + Papaya (66%) + Mukhikachu (40%) and lowest pineapple equivalent yield (42.02 t ha^{-1}) was obtained from T_1 (sole pineapple). The highest gross return (Tk. 663750 ha^{-1}) and gross margin (Tk. 319387 ha^{-1}) was obtained from the treatment T_4 and the lowest gross return (Tk. 472725 ha^{-1}) and gross margin (Tk. 215113 ha^{-1}) was obtained from the sole pineapple.

Intercropping of amaranth, jute (AS leafy vegetable) and Panikachu with potato

The experiment was conducted in the farmers' field at FSRD site, Atia, Tangail under AEZ-8 during the year of 2018-19 to fit the suitable intercropped combination and also to increase productivity and income. The treatment combinations used for the experiment were T_1: Potato +BARI Panikachu-4, T_2: Potato + BARI Panikachu-4+Sobuj Datashak, T_3: Potato + BARI Panikachu-4 + Jute leaf (Patshak) and T_4: Potato + BARI Panikachu-4+Sobuj Datashak + Jute leaf (Patshak). Results showed that all the relay cropping combinations showed superior in terms of gross return, gross margin and potato equivalent yield (PEY) than Farmers' Practice. The highest potato equivalent yield (88.11 t ha^{-1}) was obtained in T_4 treatment which gave maximum gross margin (Tk. 1017632 ha^{-1}) followed by T_3 (Tk. 991182 ha^{-1}). The lowest gross margin (Tk. 924100 ha^{-1}) was obtained from T_1 treatment.

Intercropping of onion and mukhikachu in Bogra region

An intercropping based experiment was conducted at MLT site, Shibganj, Bogura during the two consecutive years from 2017-18 to 2018-19 with a view of growing onion as an intercrop with mukhikachu for higher yield and economic return. There were four treatments i.e. T_1: Sole mukhikachu, T_2: Sole onion, T_3: Single line onion intercropped with mukhikachu and T_4: Double line onion intercropped with mukhikachu. Spacing for mukhikachu was 60 cm x 10 cm and for onion was15 cm x 10 cm, respectively. Higher system yield (Mukhikachu equivalent yield, 29.03 and 26.59 t ha^{-1}) was recorded from the intercropping system (T_4 and T_3). Sole onion (T_2) produced the lowest equivalent yield (15.31 t ha^{-1}). Maximum gross return (Tk. 725750 ha^{-1}) and gross margin (Tk. 475750 ha^{-1}) were recorded from T_4 treatment followed by T_3 and the minimum (Tk. 382800 and 150800 ha^{-1}) from T_2 treatment. The total variable cost for sole onion and sole mukhikachu was Tk. 232000 and 202500 ha^{-1}, respectively. The maximum variable cost was obtained from T_4 treatment (Tk. 250000 ha^{-1}).

Intercropping of onion and chilli at charland of Mymensingh

The experiment was carried out at the farmers' field of Gouripur upazila, under On-Farm Research Division, Bangladesh Agricultural Research Institute, Mymensingh to find out a suitable intercropping system of onion and chilli in increasing crop productivity and profitability during 2017-18 and 2018-19. For this instance, the treatments were consisted of T_1=Sole chilli, T_2=Sole onion, T_3= One row of onion in between two rows of chilli, T_4=Two rows of onion in between two rows of chilli and T_5=Three rows of onion in between two rows of chilli. Between the intercropped treatments, one or two rows of onion in between two rows chilli showed higher chilli equivalent yield (19.84 and 33.4 t ha^{-1}) and land equivalent ratio 1.55 and 1.33 as compared to other treatments.

C. Mixed Cropping

Performance of mixed cropping in char areas of Gaibandha

The experiment was undertaken at Chinirpotol char, Saghata, Gaibandha during the year of 2019-20 to find out the suitable ratio of chilli, Brinjal, radish, and coriander under mixed cropping and ensure the maximum utilization of the land for higher yield and economic return. The experiment was designed in a randomized complete block design with three dispersed replications. In this experiment, chilli (BARI Morich-3), Brinjal (BARI Bt Begun-4), radish (BARI Mula-1), and coriander (BARI Dhania-1) were grown mixed using additive percentages. Four mixed cropping ratios with one sole chilli viz: T_1: 100% chilli + 70% Brinjal + 20% Radish + 10% coriander, T_2: 100% chilli + 50% Brinjal + 30% radish + 20% coriander and T_3: 100% chilli + 30% Brinjal + 40% radish + 30% coriander, T_4: Sole chilli (100%) and T_5: Farmers practices' (100% chilli + 80% Brinjal + 70% radish + 50% coriander). The maximum chilli equivalent yield (29.7 t ha^{-1}), gross return (Tk. 891000 ha^{-1}) and gross margin (Tk. 776700 ha^{-1}) was found from T_4. The minimum chilli equivalent yield (11.7 t ha^{-1}), gross return (Tk.351000 ha^{-1}), and gross margin (Tk. 238950 ha^{-1}) were found from T_4. The maximum MBCR was also recorded in T_3. The minimum MBCR was recorded in sole chilli. It was found that 100% chilli mixed with 30% Brinjal, 40% radish, and 30% coriander produced higher yield and economic return.

D. Relay Cropping

Performance of grass pea varieties relaying with T. Aman rice in Bhola

The experiment was conducted at Dawlatkhan, Bhola under AEZ-18 in the *rabi* season of 2019-20 to observe the performance of BARI developed grass pea varieties and to compare it with local variety in relay with T. Aman rice under farmers' field condition. BARI Khesari-2, BARI Khesari-3 and local variety was tested in this study. The experiment was laid out in a RCB design with six dispersed replications. BARI Khesari-2 produced 1.36 t ha^{-1} *seed followed by* BARI Khesari-2 (1.24 t ha^{-1}). *The lowest yield* (0.91 t ha^{-1}) *was obtained from local grasspea variety.* It was 23.51% higher compared to local variety. Due to higher seed yield BARI Khesari-3 showed higher gross return (Tk.54400 ha^{-1}) gross margin (Tk.30635 ha^{-1}) and also higher BCR (2.29).

Performance of garden pea relay with T. Aman rice in Bhola

The experiment was conducted at Sadar and Daulatkhan, Bhola under AEZ-18 in the *rabi* season of 2019-20. Performance of BARI developed garden pea variety was tested under farmers' field condition in relaying with T. Aman rice and Line sowing method after T. Aman rice harvest to select suitable and profitable planting method for Bhola region. BARI Motorshuti-1 was tested for this study. The experiment was laid out in a RCB design with six dispersed replications. BARI Motorshuti-1 produced higher green pod yield (6.25 t ha^{-1}) at Line sowing method than relay methods (5.86 t ha^{-1}). Due to higher green pod yield in Line sowing method showed higher gross return (Tk.250000 ha^{-1}) but BCR (5.5) and gross margin (Tk.191620 ha^{-1}) was found higher in relay method due to lower total variable cost.

Screening of relaying crops in the rice-based cropping system of coastal saline char area

The study was conducted in such kinds of fields where sowing of crops was hampered due to late withdrawal of the monsoon delay drying of soil, shortage of soil moisture, lack of irrigation facilities and moderate to highly saline lands which was previously kept fallow at Bangla bazar, Sadar and West Al-Amin, Subarnachar and Kellar Char, Companiganj upazila under Noakhali district during the *rabi* season of 2019-20. The main objectives of the study to select an economical viable relay cropping system for the moderate to highly saline fallow areas where commonly grown Rabi crops such as grass pea, field pea, mustard, linseed, mungbean, cowpea, soybean, chilli, sunflower were included as a treatment in this experiment. The result revealed that the variety Chilli (dry) gave highest (3.325 t ha^{-1}) rice equivalent yield and gross margin (Tk. 35640 ha^{-1}). In case of pulse crops, field pea gave the highest (Tk. 25,935 ha^{-1}) gross margin and second highest (2.23 t ha^{-1}) rice equivalent yield. On the other hand, linseed gave the higher gross margin (Tk. 28,376 ha^{-1}) due to less total variable cost and price of linseed was more (Tk. 50 per Kg) in local market. Moreover, sunflower was not suitable for relay cropping rather it could be drilled after harvesting of T. Aman.

Effect of sowing time on the performance of coriander as relay crop with B. Aman rice

A field experiment was conducted at Mohichail, Chandina under On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Cumilla during the *rabi* season of 2019-20 to study the effect of sowing time on the performance of Coriander as relay crop with B. Aman rice. The experimental treatments include 3 dates of sowing viz., S_1= Relay sowing of Coriander before 15 days of B. Aman harvest (14 November), S_2= Relay sowing of Coriander before 10 days of B. Aman harvest (19 November), S_3= Relay sowing of Coriander before 5 days of B. Aman harvest (24 November). Results revealed that sowing time had significant influences on various crop characters and seed yield of relayed coriander. Among the three different sowing times, S_1 (Sowing on 14 November i.e relay sowing of coriander before 15 days of B. Aman harvest) was superior in relation to plant population, plant height, number of branches plant^{-1}, number of umbel plant^{-1}, number of umbellate umbel^{-1} and number of seeds umbellate^{-1} compared to S_2 (19 November) and S_3 (24 November) treatments which resulting the highest seed yield of 1.19 t ha^{-1}. In case of cost and return analysis, the highest gross return (Tk.89250.00 ha^{-1}) and gross margin (Tk. 63340.00 ha^{-1}) was recorded from BARI Dhonia-2 sown on 14 November i.e relay sowing of coriander before 15 days of B. Aman harvest.

Performance of wheat varieties as relay crop with B. Aman rice in Cumilla region

The experiment was conducted at the farmer`s field of Metanghar, Muradnagar, Cumilla under On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Cumilla during the *rabi* season of 2019-2020 to study the performance of wheat varieties as relay crop with B. Aman rice. The experimental treatments included two varieties viz. V_1= BARI Gom-25 and V_2 = BARI Gom-33. The experiment was laid out in a randomized complete block design with three dispersed replications. The variety, BARI Gom-25 was superior in respect of number of plant population, tiller plant^{-1} and yield. But BARI Gom-33 was superior in plant height, spikelet spike^{-1}, spike length, grain spike^{-1} and thousand grain weight. Though maximum yield contributing characters were superior in BARI Gom-33 but the yield was higher in BARI Gom-25, due to higher plant population and effective tiller plant^{-1} in BARI Gom-25. Thus, higher gross return and gross margin were also found from BARI Gom-25.

Performance of mustard varieties as relay crop with B. Aman rice in Cumilla region

The experiment was conducted at the farmer`s field of Matangor, Muradnagar, Cumilla and

Purbo Hatila, Hazigonj in Chandpur under On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Cumilla during the *rabi* seasons of 2019-20 to study the performance of mustard varieties as relay crop with locally cultivated B. Aman rice. The experimental treatments included 5 varieties viz. V_1= BARI Sarisha-9, V_2 = BARI Sarisha-14, V_3 = BARI Sarisha-15, V_4= BARI Sarisha-17 and V_4 = Tori-7. The experiment was laid out in a randomized complete block design with four dispersed replications. There was a strong varietal influence of relay cropping on crop growth and seed yield of mustard. Among the varieties, BARI Sarisha-17 showed the best results in terms of number 1000 seed yield resulting in the highest seed yield of 1494.00 Kg ha^{-1}.Among the mustard varieties in relay planting system, BARI Sarisha-17 offered the highest gross return of Tk. 56772.00 ha^{-1} coupled with gross margin Tk.43372.00 ha^{-1}. Though total cost was the same, BARI Sarisha-17 showed the higher benefit over others BARI developed and local varieties due to yield differences. Seed yield of the BARI developed varieties was lower due to late sowing and heavy rain in early growth season.

Performance of field pea as relay cropping with T. Aman rice

An experiment was carried out at Jhikargacha MLT site, Jashore during the year of 2018-19 and 2019-20. Three treatments *viz*., T_1= BARI Motor-1, T_2= BARI Motor-3 and T_3= Local were used in the experiment. The experiment was laid out in RCB with 3 replications. Yield and yield contributing characters of field pea were influenced significantly due to relay cropping with T. Aman. The highest yield (2.85 t ha^{-1}) was obtained from BARI Motor-3 followed by BARI Motor-1 (2.64 t ha^{-1}) and this was lowest from Local (2.57 t ha^{-1}). The highest gross margin (Tk. 77450 ha^{-1}) and benefit cost ratio (4.97) was found from BARI Motor-1. The lowest gross margin (Tk. 67300 ha^{-1}) and benefit cost ratio (4.45) was found from local.

E. Component Technologies

Effect of tillage options and residue retention on lentil- T. Aman rice cropping pattern in high barind tract

Conservation agriculture (CA) is based on minimum soil disturbance, residue retention, and crop rotation; it is promoted as a sustainable alternative to systems involving conventional tillage. The field trial was conducted at the farmer's field of FSRD site, Basantapur, Godagari, Rajshahi during the year of 2018-19 to observe the performance of the crops under different tillage and residue management for Lentil- T. Aman rice cropping pattern in the High Barind Tract. Two tillage options viz. (i) ST= strip tillage and (ii) CT= conventional tillage; and three crop residue managements, viz. (i) R_0=no residue (ii) R_{20}=20% residue (iii) R_{30}=30% residue retention were studied. The experiment was laid out in split plot design with tillage option in main plot and residue retention in sub-plot. The trial was replicated three times. There was no yield difference between ST and in CT in lentil and T. Aman rice but higher rice equivalent yield (REY) was obtained from ST method. Among the residue management, 20% residue retention showed the highest yields in lentil (1.49 t ha^{-1}), T. Aman rice (4.69 t ha^{-1}) and REY (10.66 t ha^{-1}). The results also indicated that, ST coupled with 20% residue retention produced the maximum REY (11.01 t ha^{-1}). Treatment ST with 20% residue retention also showed higher gross margin and BCR. The ST with 20% residue retention might be a good option for higher productivity of Lentil- T. Aman rice cropping pattern in High Barind Tract of Bangladesh.

Weed management in lentil under tillage options in high barind tract

The field trial was conducted at the farmer's field of FSRD site, Basantapur, Godagari, Rajshahi during the year of 2018-19 (Yr1) and 2019-20 (Yr2) to observe the performance of the crops under different tillage and weed management strategies for lentil in the High Barind Tract. The experiment was conducted in split plot design with three replications. Two tillage methods viz. (i) ST= strip tillage and (ii) CT= conventional tillage; and five weed management options viz. (i) W_1= Pre-sowing

(Glyphosate) (ii) W_2= Pre-emergence (Pendimethalin) (iii) W_3= Post-emergence (Fenoxaprop-p-ethyl), W_4= Hand weeding, and W_5 = Control (No weeding) were studied. The ST system gave numerically higher yield of lentil. Among the residue management, W_2 which includes pendimethalin showed the highest yields of lentil (1.81 and 1.64 t ha^{-1}in Yr1 and Yr2, respectively) followed by W_1 (1.67 t ha^{-1}in Yr1 and 1.54 t ha^{-1}in Yr2). The weed population and biomass were slightly higher in ST system than that of CT in Yr1 but no difference was observed in Yr2. Weed management treatment W_2 recorded minimum weed population and dry weed biomass. The results indicate that, ST coupled with W_2 and CT with $W_{2\ gave}$ the maximum lentil yield and minimum weed population. It can be concluded that Pendimethalin is effective herbicide for controlling weed in lentil field either in strip tillage or in conventional tillage system in High Barind Tract of Bangladesh.

Effect of row distance and irrigation on the yield of lentil under strip tillage system

The field trial was conducted at the farmer's field of FSRD site, Basantapur, Godagari, Rajshahi during the year of 2018-19 and 2019-20 to find out the suitable spacing and irrigation regime for increasing lentil production in High Barind Tract. The experiment was conducted in split plot design with three replications. Two row spacing *viz*., (i) R_{20}= 20 cm apart from row and (ii) R_{30}=30 cm apart from row; and four irrigation regimes (light irrigation), viz. (i) I_1=One irrigation at vegetative stage (ii) I_2=One irrigation at pod setting stage (iii) I_3=Two irrigation at vegetative and pod setting stages and (iv) I_4=Control (No irrigation).The R_{30} gave numerically higher seed yield of lentil. Among the irrigation level, I_3 showed the highest yields of lentil (1.66 and 1.59 t ha^{-1} in 2018-19 and 2019-20, respectively). The results indicate that, 30 cm row distance coupled with two irrigation might be a good option for higher yield of in High Barind Tract of Bangladesh.

Bio-rational based management techniques for the control of mango fruit fly, *Bactrocera dorsalis* in Rajshahi region

Adaptive trials were conducted at farmer's field of 4 different locations of Charghat and Bagha upazila of Rajshahi district during the mango fruiting season of 2020 in a randomized complete block design with 3 treatments and 10 replications. Among the treatments, Methyl euginol pheromone trap was more effective in catching mango fruit fly male adult populations as compared to attract and kill method. But attract and kill method can catch both of male and female populations. The lowest fruit infestation (2.6 – 4.2%) was found in attract and kill method as compared to methyl euginol pheromone trap (3.5 – 4.2%). The highest infestation was found in farmer's practice (6.5 – 9.7%). Both of methyl euginol and attract & kill method effectively reduced mango fruit fly infestation as compared to farmer's practice.

ICM techniques in reducing flower and fruit dropping of mango in high barind tract

On-farm trials of Integrated Crop Management (ICM) techniques were conducted during the year of 2019-20 mango season at farmer’s field of two different regions of High Barind Tract (HBT) to increase mango production by reducing flower and fruit dropping following randomized complete block design (RCBD). ICM package includes: application of recommended fertilizer dose; two sprays with imidacloprid (Confidor) 70 WG @ o.2 g/litre of water with mancozeb (Indofil) M 45 @ 2.0 g/litre of water- 1st spray within 10 days of flowering and 2nd after one month of the first application; three irrigations starting from full bloom to fruit maturity at 15 days interval; two sprays with 2% urea solution at pea and marble stages of fruit growth were done. On the other hand, non-ICM package includes farmer’s practice only. Results indicated that 39 to 51.96% mango fruits and 12.75 to 36.97% yield were increased in ICM packages compared to non-ICM practices at two different study areas.

Yield maximization of early planted okra with high density planting

A field experiment was conducted at the MLT site, Paba, Rajshahi during the year of 2018-19 and 2019-20 to evaluate the performance of Okra at different planting densities under farmers’ field condition. The tested spacing were;S_1= 50 cm × continuous, S_2=50 cm × 20 cm and S_3=50 cm × 40 cm. The experiment was designed in RCB with three dispersed replications. Higher yield (35.63 t ha^{-1}) and gross margin (Tk.390802 ha^{-1}) were found in S_1. Farmers prefer S_1 due to its easy seeding, higher yield and economic return.

Effect of planting geometry on yield of maize at hill valleys of Bandarban

The experiment was conducted to evaluate the effect of plant geometry (row and plant to plant spacing: 60 × 25, 50 × 15, 50 × 20, 50 × 25, 40 × 15, 40 × 20, and 40 × 25 cm) on growth and yield of maize at Bakichara hill valleys in Bandarban during the *rabi* season, 2019-2020. Spacing, however, influenced seeds per cob, thousand grain weight and yield of maize. As spacing increases, yield contributing characters tend to increase with certain spacing, then decrease with the increasing of spacing. The highest number of seeds cob^{-1} (550.59) and yield (9.62 t ha^{-1}) were found at 50 cm × 25 cm spacing followed by (60 cm × 25 cm, 40 cm × 25 cm, 50 cm × 20 cm, 50 cm × 15 cm, 40 cm × 20 cm and 40 cm × 1) cm.

Effect of spacing on potato yield under zero tillage in coastal saline soil of Bangladesh

Zero tillage potato cultivation could be an alternative way of crop intensification in the coastal fallow land of Bangladesh. However, tuber yield in zero tillage practice is becomes lower and less economically viable in comparison to conventional practice if followed recommended spacing of 60 cm X 25 cm. Since canopy coverage and plant growth is lower in zero tillage practice than conventional tillage practice. So, therefore in order to increase tuber yield an experiment was conducted at farmer's field at Dacope, Khulna during rabi, 2019-20 in order to determine optimum spacing of zero tillage potato. There were four spacing treatments viz. S1= 60 cm X 20 cm, S2 = 50 cm X 20 cm, S3= 40 cm X 20 cm and 30 cm X 20 cm. There spacing were tested on two potato varieties viz. BARI Alu-72 and 73. The experiment was conducted flowing randomized complete block design with three replications. Results showed that highest tuber yield was produced from S3 (23.6 t ha^{-1}) S3 (40 cm X 20 cm) and statistically similar yield produced from S4 (22.1 t ha^{-1}) spacing. However, based upon cost involvement and potato price @15 Tk. kg^{-1} highest gross margin (Tk. 246,778) was calculated from S3 (40 cm X 20 cm) as well as benefit cost ratio (2.30).

Effect of sowing and harvest date on yield and quality of spinach in south-western saline soil

An experiment was conducted at farmer's field at Dacope, Khulna during *rabi*, 2019-20 to determine suitable sowing and harvest time as well as reasonable taste quality. The experiment consisted three sowing dates *viz*., 16 January 2020 (S1), 26 January 2020 (S2) and 5 February 2020 (S3) and four harvest time *viz*., 30, 40, 50 and 60 days after sowing (DAS). The experiment was designed in a randomized complete block design with three replications. After harvesting each time fresh plant samples were weighted for yield calculation and determining dry biomass and quality parameters *viz*., electrical conductivity (EC), pH and brix% of the extract, and sensory evaluation. Single effect of sowing date showed that fresh yield of spinach was significantly highest (27.81 t ha^{-1}) in 16 January sowing (S1), while in terms of harvest date yield was highest when harvested at 60 DAS (29.67 t ha^{-1}). However, quality parameters went down gradually when harvest was delayed after 30 DAS.

Effect of cover crops for salinity management in sunflower

An experiment was conducted at farmer's field at Dacope, Khulna during rabi season of 2019-20 in order to cultivate sunflower with different leafy vegetables as cover crops so that soil salinity is reduced and increase system productivity. The experiment treatment consisted five treatment *viz*., T_1= Sunflower with rice straw, T_2= Sunflower + Spinach, T_3= Sunflower + Ghee Kanchan (Shobuj Shak), T_4= Sunflower + Red Amaranth and T_5= Sunflower without mulch (control). Treatments were designed in randomized complete block design with three replications. Growth, yield and yield components of sunflower did not vary significantly. However, numerically highest seed yield (2.51 t ha^{-1}) of sunflower was recorded from T_3 treatment (Sunflower + Ghee Kanchan). Highest sunflower equivalent yield (2.95 t ha^{-1}) was calculated from T_2 treatment (Sunflower + Spinach), which ultimately brought highest gross return Tk. 132550, gross margin (Tk. 106550) and highest BCR (4.10).

Optimization of okra spacing and sowing dates in the south-western saline soils of Bangladesh

An experiment on okra sowing date and spacing was undertaken at MLT site, Batiaghata, Khulna during *rabi* 2019-20. The aim of the experiment was to find out optimum sowing date(s) and spacing(s) so that maximum yield is obtained. Since, okra is usually grown in summer season in other areas of the country; farmers in Khulna area cultivate okra after T. Aman harvest with closest spacing. So, for yield maximization and higher economic yield we had taken two sowing dates viz. 15 January 2020 (SD1) and 20 February 2020 (SD2) and three plant to plant spacing *viz*., 40 cm X 10 cm (SP1), 40 cm X 20 cm (SP2) and 40 cm X 30 cm (SP3). Two factorial Randomized Complete Block Design (RCBD) was adopted with three replications. Results shows that yield and yield components were found higher in 20 February (SD2) sowing (10.38 t ha^{-1}) than 15 January (SD1 (8.85 t ha^{-1}). In case of spacing, highest yield was recorded from SP2 (11.95 t ha^{-1}). No interaction effect of sowing dates and spacing were observed.

Effect of planting dates on the yield of bt brinjal

The trial was conducted in the farmer's field at 4 no. Koyra during the year of 2019-20 to study the performances of two Bt brinjal varieties *viz*., BARI Bt Begun-2 (V_1) and BARI Bt Begun-4 (V_2) in the coastal region. Among the varieties number of fruits per plant was found highest in T_1 (27 November 2019) was 48.98 t ha^{-1}followed by T_2 (13 December 2019) was 41.65 t ha^{-1} and T_3 (30 December 2019) was 21.24 t ha^{-1}. An interaction T_1V_1 the highest yield was (51.32 t ha^{-1}) and the lowest wasT_3V_2 (16.71 t ha^{-1}). The highest gross return (Tk. 587760 ha^{-1}), gross margin (Tk. 432190 ha^{-1}) and BCR (3.78) was also obtained from T_1 and lowest from T_3.

Effect of mulching on yield of watermelon in coastal area

An experiment was conducted at MLT site Kuakata, Patuakhali in the rabi season of 2019-20 to verify the effect of different mulch materials for watermelon production under farmers field condition. Three different much materials were tested viz. T_1= Silver color polythene mulch, T_2= Straw mulch, T_3= No mulch along with three types of aged seeding *viz*., P_1= 15 days old poly bag seedling, P_2 = 20 days old poly bag seedling and P_3 = direct seeded combination. All the plant growth, yield and quality characters were superior in silver polythene with 20 days old poly bag seedling (31.38 t ha^{-1}) while plants without mulch (control) and direct seeded resulted (25.53 t ha^{-1}) poor growth and yield. With economic point of view, silver mulch and 20 days old poly bag seedling combination resulted in the highest net return and found to be more economical with highest BCR**.**

Weed controlling efficacy of herbicides in wheat-mungbean- T. *Aman* rice cropping pattern under conservation agricultural systems

Conservation agriculture (CA) is a climate smart resource conserving technology. Weed management is an integral part in this system to get attainable yield and for controlling weeds the dependency on herbicide is high in CA systems. Therefore, a study was designed and executed for two years to evaluate the performance of herbicides in controlling weeds of rice and wheat and also to identify the effective herbicides for rice-wheat-mungbean cropping pattern under CA systems. The study was initiated with wheat during the rabi season of 2017-18 at the on-station field of On-Farm Research Division, BARI, Gazipur. This study was continuously done for two years and completed with T. Aman rice during the year of 2019. In wheat, two herbicides (pendimethalin and carfentrazone-ethyl plus isoproturon) were tested as five treatments includingone 'weedy' check and one 'weed-free' check. In T. Aman rice, three herbicides (pretilachlor, pyrazosulfuron-ethyl and bispyribac-sodium) were tested as eight wee control treatments during the year of 2018 and as six treatments during the year of 2018 including one 'weedy' check and one 'weed-free' check. Two-year study identified that the wheat field was infested with three grass weeds (*Cynodon dactylon*, Digitaria sanguinalis and Echinochloa colona) and five broadleaf weeds (*Polygonum hydropiper*, *Physalis heterophylla*, *Chenopodium album*, *Eclipta prostrate* and *Portulaca oleracea*). Application of pendimethalin followed by carfentrazone-ethyl plus isoproturon effectively controlled on all types of weeds. This treatment produced the highest grain and straw yields of wheat. In case of T. Aman rice, the study found that application of pyrazosulfuron-ethyl followed by bispyribac-sodium was the most effectual treatment that offered most effective weed control as well as produced the highest grain and straw yields. Therefore, the study suggests application of pendimethalin followed by carfentrazone-ethyl plus isoproturon for wheat and pyrazosulfuron-ethyl followed by bispyribac-sodium for T. Aman riceto control weeds effectively in wheat-mungbean-T. Aman rice cropping pattern under CA systems; but the label rate application of herbicide should be strictly followed.

Effect of planting date on growth, harvested leaves and seed yield of mustard green (lai shak) in Sylhet region

A field experiment was conducted at Guptorgao under south surma of Sylhet during *rabi* of years 2017-2018 and 2018-19. The soil was clay loam in texture and acidic in nature, pH ranges 5.5-6.57. The experimental treatments consist of five different dates of seedling transplant *viz*., T_1: 15 October, T_2: 30 October, T_3: 15 November, T_4: 30 November and T_5: 15 December. The experiment was laid out in randomize complete block design with four replications. The mustard green (Lai shak) seedlings were raised by following farmer's agronomic cultural practices. From the result, 15 November transplanting recorded significantly higher crop yield attributing characters viz. harvested leaves plant^{-1}, weight of single leaf, siliqua^{-1} and weight of 1000-seed and ultimately seed yield (1.38 t ha-1). The highest monitory benefit such as gross return (TK. 1283684 ha^{-1}) and gross margin (TK. 1048140 ha^{-1}) was calculated from T_3 (15 November planting) followed by T_2 (30 October planting).

Effect of planting dates on the yield of Bt brinjal

The trial was conducted in the farmer's field at 4no. Koyra during the year of 2019-20 to study the performances of two Btbrinjal varieties viz. BARI Bt Begun-2(V_1) and BARI Bt Begun-4 (V_2) in the coastal region. Among the varieties number of fruits per plant was found highest in T_1(27 November 2019) was 48.98 t ha^{-1}followed by T_2 (13 December 2019) was 41.65 t ha^{-1} and T_3 (30 December 2019) was 21.24 t ha^{-1}. Treatment T_1V_1 gave the highest yield (51.32 t ha^{-1}) and lowest in T_3V_2 (16.71 t ha^{-1}). The highest gross return (Tk. 587760 ha^{-1}), gross margin (Tk. 432190 ha^{-1}) and BCR (3.78) was also obtained from T_1 and lowest from T_3.

Effect of border trees on potato in northern region of Bangladesh

The experiment was conducted at multi-location testing)MLT(site Gobindaganj, Gaibandha during the *rabi* season of 2018-2019 and 2019-2020 to evaluate the effect of border trees on crop production in northern region of Bangladesh**.** The experiment consisted of two treatments viz. T_1=Normal potato field, T_2=Tree surrounded potato field a popular potato variety was used in this study. The experiment was laid out in randomized complete block design with three replications. Open field potato cultivation produced significantly higher tuber yield compare to tree surrounded potato filed. In 2018-2019, the highest tuber yield was recorded in T_1 (31.10 t ha^{-1}). The lowest tuber yield was recorded in T_2 (18.45 t ha^{-1}). The highest gross margin (Tk.114219 ha^{-1}) was found from T_1 and lowest was in T_2 treatment. It was found that border trees reduced the crop yield as well as decreased the economic income of the farmers. Similar results also found in 2019-20.

Effect of detopping of maize on grain and fodder yield of zero tillage maize in haor areas of Kishoreganj

A field study was conducted at Goroy, Nikli upazila under OFRD, BARI, Kishoreganj during the *rabi* seasons of 2019-20, to observe the detopping effects of maize on grain and fodder yield. The experiment was laid out in a randomized complete block design with three replications. It included three treatments i. e; 1. Detopping at 25 days after pollination, 2. Detopping at 35 days after pollination 3. Without detopping (control). The variety was BARI Hybrid Maize-9. Among the treatments the highest yield was found from farmer's practice (9.5 tha^{-1}) followed by Detopping at 35 days after pollination (9.0 tha^{-1}) and the lowest yield from detopping at 25 days after pollination (8.13 t/ha).The highest gross margin (Tk.94900 ha^{-1}) and BCR (2.24) was calculated from farmer's practice followed by detopping at 35 days after pollination (Tk. 73500 ha^{-1}).

Effect of different planting system of chilli in the char areas of kishoreganj

The study was conducted at the farmers' field of Maria, Kishoreganj Sadar, during the *rabi* season 2019-20 to find out the suitable planting system of chilli for the char area. Three different planting systems such as; T_1: broadcasting chilli (Farmers' practice), T_2: continuous sowing in double row and T_3: transplanting in double row was tested in this study. The variety of chilli was Nodaria (local). The significantly highest yield (8.33 tha^{-1}) was found from T_2 treatment and the lowest yield was obtained from T_3 (7.13 tha^{-1}). According to cost and return analysis, T_2 treatment gave the maximum gross return (208250 Tk/ha), gross margin (114750 Tk/ha) as well as maximum benefit cost ratio (2.23).

Effect of sowing time on leafy coriander production

An experiment was conducted at On Station of OFRD, BARI, Rangpur round the year of 2019-20 to evaluate the performance of coriander varieties with sowing dates. Three coriander varieties *viz.*, BARI Dhania-1, BARI Dhania-2 and local with twenty-four sowing dates, 15 days' interval started from 15 October were tested. Among the tested varieties, the highest fresh leaves yield was obtained from BARI Dhania-2 variety (3.91 t ha^{-1}), where 1st November sowing dates produced maximum leaves yield (5.93 t ha^{-1}). The lowest fresh leaves yield was obtained from BARI Dhania-1 variety (2.85 t ha^{-1}) and the poor yielder sowing time was 15 March (1.37 t ha^{-1}) though the other hot and rainy month (April to mid-September) could not grow the coriander crop. Though the yield was relatively low but the gross margin was higher in 15 February (297300 Tk. ha^{-1}), 15 September (224200 Tk. ha^{-1}), 01 March (210900 Tk. ha^{-1}) due to higher market price.

F. Agroforestry

Performance of intercropping jute leaf with summer vegetables under mango based agroforestry system

An experiment was conducted at the farmers' fields of Debidwer and Sadar Dakkhin of Cumilla and Kachua of Chandpur during the summer season of 2019 to evaluate the performance of intercropping jute leaf with mukhikachu, bottle gourd, sponge gourd and okra under mango based agroforestry system, to increase the production of vegetables by using the fallow land under mango garden and income of the farmers in this region. The highest jute leaf equivalent yield (73.72 t ha^{-1}), gross return (737.22 Th Tk ha^{-1}), net return (623.05 Th Tk ha^{-1}) and BCR (6.45), were found from inter cropping jute leaf with mukhikachu followed by inter cropping jute leaf with bottle gourd and the lowest from inter cropping jute leaf with sponge gourd in agroforestry system (42.95 t ha^{-1}, 429.57 Th Tk ha^{-1}, 310.25 Th Tk ha^{-1} and 3.6 respectively). Sole mango gave much lower yield and economic return than all the agroforestry systems.

Performance of intercropping jute leaf with turmeric under mango based agroforestry system

An experiment was conducted at the farmers' fields of Sadar Dakkhin, Cumilla and Kachua, Chandpur during March 2019 to February 2020 to evaluate the performance of intercropping jute leaf with three BARI developed turmeric varieties with one local as check variety under mango based agroforestry system, to increase the production and income of the farmers in this region. The highest total jute leaf equivalent yield (71.38 t ha^{-1}) was found from intercropping jute leaf with BARI Halud-4 under mango-based agroforestry system and the lowest total jute leaf equivalent yield (49.49 t ha^{-1}) was found from intercropping jute with BARI Halud-5.

Performance of inter cropping red amaranth with tomato sweet gourd and bottle gourd varieties under mango based agroforestry system

An experiment was conducted at the farmers' fields of Debidwer and Sadar Dakkhin of Comilla and Kachua of Chandpur during the Rabi season of 2019-20 to evaluate the performance of intercropping red amaranth with tomato, sweet gourd and bottle gourd varieties under mango based agroforestry system, to increase the production of vegetables by using the fallow land under mango garden and income of the farmers in this region. The highest total red amaranth equivalent yield (51.15 t ha^{-1}), gross return (593.37 $ThTkha^{-1}$), net return (475.00 ThTkha^{-1}) and BCR (5.01),were found from BARI tomato-14 cultivation and the lowest from BARI Hybrid Mishtikumra-1(sweet gourd) in agroforestry system (25.04 t ha^{-1}, 300.17 ThTkha^{-1}, 175.67 Th Tk ha^{-1} and 2.41 respectively).

Performance of sweet gourd varieties under fruit tree based agroforestry system in hill slopes of Bandarban

The experiment was conducted at the farmers' field of Tetulia para hill slopes of Rowangchari upazila in Bandarban during the kharif-1 season of 2020 to evaluate the performance of different sweet gourd varieties viz. V_1=BARI Hybrid Mistikumra-1, V_2=BARI Hybrid Mistikumra-2 and V_3=Hybrid Maya under different planting system viz. $T_{1=}$ Mango based agroforestry system, $T_{2=}$ Mango+Papaya based agroforestry system and $T_{3=}$ Sole vegetables. Interaction between sweet gourd varieties and planting systems, tested in this experiment, showed significant variation in fruit weight (kg fruit^{-1}), yield (t ha^{-1}) and economic return (Tk. ha^{-1}). Highest yield (13.35 t ha^{-1}), gross return (Tk. 267000 ha^{-1}), net return (Tk. 157000 ha^{-1}) and BCR (2.43) were found in interaction V_2T_2= (BARI Hybrid Mistikumra-2 under mango+papaya based agroforestry system) followed by V_2T_1, V_3T_2, V_1T_2, V_3T_1, V_1T_1, V_2T_3 and V_3T_3. Lowest result was found in interaction V_1T_3= (sole BARI Hybrid Mistikumra-2) in yield (9.78 t ha^{-1}), gross return (Tk. 195600 ha^{-1}), net return (Tk. 85600 ha^{-1}) and BCR (1.78).

Performance of bottle gourd varieties under mango based agroforestry system in hill slopes of bandarban

The experiment was conducted at the farmers' field of Tetulia para hill slopes of Rowangchari upazila in Bandarban during the *kharif*-1 season of 2020 to evaluate the performance of bottle gourd varieties viz. BARI Lau-3, BARI Lau-4 and Hybrid Daina under mango based agroforestry system to increase the production of vegetables by using the fallow land under mango garden and generate additional income of the farmers in this region. Bottle gourd varieties, tested in this experiment, showed significant variation in yield (t ha^{-1}) and economic return (Tk. ha^{-1}). Highest yield (26.22 t ha^{-1}), gross return (Tk. 393300 ha^{-1}), net return (Tk. 283300 ha^{-1}) and BCR (3.58) were found from BARI Lau-4 followed Hybrid Daina (21.35 t ha^{-1}, Tk. 320250 ha^{-1}, Tk. 210250 ha^{-1} and 2.91, respectively) and the lowest from BARI Lau-3 (14.88 t ha^{-1}, Tk. 223200 ha^{-1}, Tk. 113200 ha^{-1} and 2.02 respectively) under mango based agroforestry system.

Performance of bitter gourd varieties under mango based agroforestry system in hill slopes of bandarban

The experiment was conducted at the farmers' field of Tetulia para hill slopes of Rowangchari upazila in Bandarban during the kharif-1 season of 2020 to evaluate the performance of bitter gourd varieties viz. BARI Korola-3, BARI Korola-4 and Hybrid Tiya under mango based agroforestry system, to increase the production by introducing summer vegetables and using the fallow land under mango garden. Bitter gourd varieties, tested in this experiment, showed significant variation in fruit number, fruit weight (g), yield (t ha^{-1}) and economic return (tk ha^{-1}). Highest yield (7.48 t ha^{-1}), gross return (Tk. 224400 ha^{-1}), net return (Tk. 134400 ha^{-1}) and BCR (2.49) were found from BARI Korola-4 followed Hybrid Tiya (6.97 t ha^{-1}, Tk. 209100 ha^{-1}, Tk. 119100 ha^{-1} and 2.32, respectively) and the lowest from BARI Korola-3 (5.46 t ha^{-1}, Tk. 163000 ha^{-1}, Tk. 73000 ha^{-1} and 1.81 respectively) under mango based agroforestry system.

Performance of pulses in mango based agro-forestry system in high barind tract

Fruit orchards are the principal agricultural crops that generate sustainable economic income to the farmers of the FSRD site, Basantapur, Godagari, Rajshahi with a view to find out the performance of mango trees and pulse crops to increase cropping intensity and productivity in the High Barind Tract. Mango tree and four pulses were used. These areas integrate a vast mango crops cultivated with high chemical inputs, open soil management and flowering stimulation. The effects of different intercropping systems with leguminous crops were integrated in a typical mango fruit region of Rajshahi. Four leguminous crops i.e. pea, grass pea, chickpea and lentil were evaluated as cash and trap crops. The trials encompass four intercropping management systems (lentil, chickpea, grass pea and pea), laid out in a RCBD design with three repetitions. In each experimental unit, growth and yield parameters of intercropped legumes and their interactions with the yield parameters of the companion fruit trees were determined. The results demonstrate the potential of leguminous crops to improve the ecological stability in traditional fruit orchards. Grain and straw yields (t ha^{-1}) of lentil, chickpea, pea and grass pea were significantly higher. In mango tree orchard, Chickpea (BARI Chola-5) achieved the highest yield of dry biomass (1.53 t/ha) and the treatment with lentil (BARI Masur-8) produced 1.36 t/ha. Pea (BARI Motor-3) showed the highest yield of dry biomass (1.16 t/ha) and the treatment with grass pea (BARI Khesari-3) produced 1.22 t/ha. The soil cover integrating leguminous crops increases soil fertility and benefits insect populations. These management systems significantly the highest height and breast diameter growth and the highest fuel wood and green leaves. The overall results imply that mango orchard can be compatible with legumes crop if both root and shoot and green biomass be incorporated into soils. In mango orchards, mango yield was the highest in combination with pea (3.62 t/ha), grass pea (3.86 t/ha), chickpea (4.14 t/ha), lentil (4.29 t/ha). Additionally, more abundance and diversity of insect population was observed when intercropping leguminous crops were grown in the mango orchards.

Development of litchi based agroforestry system with high value crops

The experiment was carried out at extrapolation areas of FSRD site Ganggarampur, Pabna Sadar, Pabna during the rabi season of 2019-20 to evaluate the performance of high value crops in association with litchi trees aiming to develop litchi-based agroforestry system and eventually increasing total productivity and farmers income. Different high value crops such as cauliflower, cabbage and broccoli were selected for growing with litchi orchards in this study. Maximum fruit equivalent yield was obtained from litchi+ cauliflower (13.21 t ha^{-1}) followed by litchi + cabbage and litchi + broccoli. Regarding economic benefit, all vegetables grown in litchi-based agroforestry system exhibited remarkably higher gross return and gross margin compared to sole litchi cultivation.

Development of guava based agroforestry system with high value crops

The experiment was carried out at extrapolation areas of FSRD site Ganggarampur, Pabna Sadar, Pabna during the rabi season of 2019-20 to evaluate the performance of high value crops in guava agroforestry system and to increase productivity and farmers income. Different high value crops such as tomato, cauliflower and cabbage were selected for guava-based agroforestry system in this study. Maximum fruit equivalent yield was obtained from guava+ cauliflower (24.69 t ha^{-1}) followed by guava + tomato and guava+ cabbage. Regarding economic benefit, all vegetables grown in guava-based agroforestry system exhibited remarkably higher gross return and gross margin compared to sole guava cultivation. However, guava + cauliflower agroforestry system is found more profitable regarding higher system productivity and economic return.

Upscaling mango based agroforestry with elephant foot yam at farmers field

The production program of mango-based agroforestry system with elephant foot yam was conducted at farmers' field of Farming Systems Research and Development (FSRD) site, Ganggarampur, Pabna during 2019-20. The higher system productivity in terms of fruit equivalent yield (FEY) of the agroforestry system with elephant foot yam was 25.85 while relatively much lower FEY (8.60) was noted in sole mango cultivation. Higher gross return (1292500 Tk. ha^{-1}) and gross margin (963400 Tk. ha^{-1}) and satisfactory MBCR (3.45) was also obtained from agroforestry system. Therefore, this agroforestry technology with mango and elephant foot yam can be recommended for wider scale extension at extrapolation areas.

Development of cropping pattern with mango based agroforestry system

The experiment was conducted at farmers' field of Farming Systems Research and Development (FSRD) site, Ganggarampur, Pabna during 2019-20 to develop suitable cropping pattern with mango-based agroforestry system for higher system productivity and farmers income. The fruit equivalent yield (FEY) of the agroforestry system with mustard-sesame cropping pattern was 6.86

while relatively lower FEY (3.75) was noted in sole mango cultivation. Higher gross return (411600 Tk. ha^{-1}) and gross margin (287025 Tk. ha^{-1}) and satisfactory marginal benefit cost ratio (MBCR) (2.12) was also obtained from agroforestry system.

Development of mango based agroforestry with fodder crops

The experiment was conducted at farmers' field of FSRD site, Ganggarampur, Pabna during 2019- 20 to develop mango-based agroforestry system with fodder crop for raising system productivity and farmers income. The fruit equivalent yield (FEY) of the agroforestry system with fodder crop was 4.91 while relatively lower FEY (3.60) was noted in sole mango cultivation. Higher gross return (294600 Tk. ha^{-1}) and gross margin (222710 Tk. ha^{-1}) was also obtained from agroforestry system. Therefore, this agroforestry technology can be disseminated at extrapolation areas for sustainable feed management of livestock and income generation.

Feasibility of growing shade tolerant crops under mango based agroforestry system

The experiment was conducted at FSRD site, Ganggarampur, Pabna during 2019-20. Five different vegetables crops namely pea, radish cabbage, cauliflower and tomato were grown under two environmental condition viz. agroforestry and open field. The yield of all vegetables was higher in open land condition except tomato but considering system productivity significantly higher vegetable equivalent yield was obtained from all vegetables under agroforestry system. The system productivity increased by 285, 86.52, 43.22, 38.40 and 28.20% in case of pea, radish, cabbage, cauliflower and tomato under agroforestry system as compared to open land condition. Higher economic return was also obtained from tomato followed by cauliflower and cabbage under agroforestry system.

G. Seaweed

Effect of lunar cycle/full moon on the yield of *Gracilaria tenuistipitata*

This investigation is done to find out how and to what extent full moon impacts on the yield of Gracilaria tenuistipitata while cultivating in open-sea. Gracilaria tenuistipitata var. liui is a red seaweed species which is highly valued for its agarose content used in producing agar-agar powder. Most of the biological laboratories use agar powder for culturing bacteria. This valuable seaweed species has a natural bed at Nuniarchara, Cox's Bazar. Since the beginning of the project this seaweed is being used as prime research material. Wave pressure is a very important factor for cultivating seaweeds following semi-floating method of cultivation in open-sea. Naturally during the time of full moon and three days before and after the full moon, wave pressure remains higher which can cause considerable yield loss. Results reveal that yield may be increased by 10 to 18 percent if we seed the crop 3 days after the full moon and harvest it 3 days before the next full moon (24 days field duration), instead of seeding at first day of the month and harvesting at last day (30 days field duration). Thus, we can save 6 days which can be used to dry and processing the harvests and also to take preparations for the next seeding.

Monthly variation on the yield of *Gracilaria tenuistipitata* var *liui* in relation with different essential water parameters at nuniarchara, cox's bazar

Seaweeds are crops of winter season. The best time to cultivate seaweed is from October to March of the year, i.e. six months a year. During these six months six cuts can be made which means that we can harvest seaweeds after one month of each seeding. But each harvest do not produce the same yield because of variation in water quality and wave pressure from month to month during the cultivation season. To find out this yield variation along with the variation in water quality, this experiment has been carried out. Month-wise production of *Gracilaria tenuistipitata* was carried out at Nuniarchara sand-flat, Cox's Bazar during October 2019 to March 2020. The highest yield was obtained in the month of January: fresh yield- 9.33 ton/ha and dry yield 1.86 ton/ha. On the other hand, the lowest yield was obtained in March: fresh yield- 6.69 t/ha and dry yield 1.34 t/ha.

Production of *Ulva lactuca* (Green seaweed from Japan) at open sea using multi-step seeds born seedlings from seaweed laboratory

This production program has been conducted to find out the yield of *Ulva lactuca* in open sea at

Nuniarchara coast, Cox's Bazar during the month of January, February and March 2020 and at the same time to identify the best production time in rabi season. Seedlings were raised in the laboratory from multi-step seeds of *Ulva lactuca*. Ropes were seeded in open sea at the beginning of each month and harvested by the end of the month. The highest yield (6.69 t/ha fresh, equivalent to 1.11 t/ha dry) was obtained in February.

Performance of *G. tenuistipitata* var. *liui* and *U lactuca* in different areas along the coast of Cox's Bazar

Seaweed has immense importance to combat against malnutrition and other critical diseases. It is being used as important raw materials of different pharmaceutical and cosmetics industries in many countries. An area with relatively calm wave pressure, high salinity ranging from 20 to 35 ppt and low turbidity is considered to be the ideal place for producing seaweeds. This present study was conducted to explore some such areas along Cox's Bazar Coast where seaweed farming can easily be carried out and pilot production is possible. This experiment was carried out in newly identified four locations; Naziarartek, Charpara, Choufoldondi and Rejukhal, along with the research plot of Nuniarchara coast. All the newly identified locations have the possibility to cultivate seaweeds, of which Rejukhal ranked the highest and the prawn producing pond (locally called gher) gave no production since there was no water movement/nutrient flows.

Nutrient management for BARI bt brinjal at high barind tract

The study was carried out at FSRD site, Godagari, Rajshahi under OFRD, BARI, Barind station, Rajshahi during the Rabi season of 2017-18, 2018-19 and 2019-20 to find out an optimum and economic fertilizer dose for transgenic Bt brinjal variety at the farmers' field of High Barind Tract. The soil of the experimental field was chemically analyzed and levels of the fertilizers were calculated on the basis of target yield as per Fertilizer Recommendation Guide' 2012. The treatments were T_1: STB fertilizer splitting as per recommendation (FRG, 2012), T_2: T_1 +25% NPK (NK splitting 5 times), T_3: T_1 +50% NPK (NK splitting 5 times), T_4: T_1 +75% NK (NK splitting 5 times), T_5: T_1 + 25% NPKS, T_6= Farmers Practices (Average of 20 Farmers). The trial consists of Brinjal var. BARI Bt Begun-4 against non Bt counterpart. The fruit yield was the maximum in T_4: (T_1+75% NK (NK splitting 5 times), nevertheless it gave the highest gross return, gross margin and BCR in three years. The lowest yield was found in T_1: STB fertilizer splitting as per recommendation (FRG, 2012) in the year of 2017-18 an 2019-20; and T_6 (Farmers Practices) in the 2018-19. The minimum gross return, gross margin and BCR were obtained fromT_6 (Farmers Practices).

Effect of fertilizer application methods on maize grown under strip tillage system in high barind tract

A field experiment was conducted in the farmer's field of FSRD site, Basantapur, Godagari, Rajshahi during Rabi 2019-20 to develop the best fertilizer application method in conservation agriculture for maize cultivation in High Barind Tract. The experiment was laid out in randomized complete block design with three replications. There were four treatments namely, T_1= fertilizer and seeds sown simultaneously on same row by strip machine, T_2= fertilizer and seeds sown simultaneously on different row by strip machine, T_3= fertilizer applied on strip manually and T_4= fertilizer broadcasted on whole plot manually. The maximum germination rate (90%) and grain yield (7.34 t ha^{-1}) was recorded in T_2 when fertilizer and seed were sown different rows simultaneously with strip machine. Contrarily, treatment T_2 where fertilzer and seed sown on same row simultaneously showed poor performance regarding germination rate (65%), grain yield (4.11 t ha^{-1}) and other parameters.

On farm of validation of bio-fertilizer in mungbean

An experiment was conducted at Bhola sadar, Bhola in 2020 to assess the effect of biofertilizer for Mungbean cultivation under farmers' field condition. The treatments of the trial were T_1=Without Rhizobium inoculant + $P_{22}K_{42}S_{20}Zn_5$ kg ha^{-1}, T_2=With Rhizobium inoculant (1.5 kg ha^{-1})+ $P_{22}K_{42}S_{20}Zn_5$ kg ha^{-1} and T_3= $N_{50}P_{22}K_{42}S_{20}Zn_5$ kg ha^{-1}. The highest seed yield (1.32 t ha^{-1}) was recorded from T_2 and lowest yield (1.04 t/ha) was from T_1 treatment. The highest gross return (72600) and BCR (2.10) was obtained from jointly use of biofertilizer and chemical fertilizer T_2 treatment.

Validation of bio-fertilizer on soybean

An experiment was conducted at MLT site Dawlatkhan, Bhola in 2020 to find out the effect of biofertilizer for Soybean cultivation under farmers field condition. Treatments of the trial were T_1=Without Rhizobium inoculant + $P_{22}K_{42}S_{40}Zn_5$ kg ha^{-1}, T_2=With Rhizobium inoculant (1.5 kg ha^{-1}) + $P_{22}K_{42}S_{40}Zn_5$ kg ha^{-1}, T_3= $N_{100}P_{22}K_{42}S_{40}Zn_5$ kg ha^{-1}. The highest seed yield (1.62 t ha^{-1}) was recorded from T_3 treatment and lowest yield (1.42 t/ha) was from T_1 treatment. The highest gross return and BCR was obtained from T_3 & T_2 treatments.

Determination of suitable zinc fertilizer dose for maize production in char areas of Gaibandha

The experiment was conducted at Chinirpotol char of Saghata, Gaibandha under the supervision of OFRD, Gaibandha during the *rabi* season of 2019-20 to determine the optimum dose of zinc fertilizer for better yield of maize in char areas. The experiment was laid out in a randomized complete block design (RCBD) with six dispersed replications. Five zinc fertilizer doses i.e. T_1= Zn 0 kg ha^{-1}, T_2= Zn 2 kg ha^{-1}, T_3= Zn 4 kg ha^{-1}, T_4= Zn 6 kg ha^{-1} and T_5= Zn 8 kg ha^{-1} were tested on hybrid maize variety (BHM-9). Other fertilizers were used as soil test based (STB). The significantly highest grain yield (10.30 t ha^{-1}) was recorded in T_5 treatment where 8 kg Zn ha^{-1} was applied and lowest yield with T_1 treatment (5.50 t ha^{-1}). Similar trends were also observed in all the other yield contributing characters. The highest gross margin (Tk. 110210 ha^{-1}) was observed in T_5 treatment due to the highest maize yield and lowest (Tk. 28250 ha^{-1}) in control (T_1) treatment.

Development of fertilizer package for chilli production in char areas of Gaibandha

An experiment was conducted in the farmers' field at Chinirpotol char, Saghata, Gaibandha during the Rabi season of 2019-20 to find out the optimum fertilizer dose for chilli cultivation in char areas. The experiment comprised with five treatments T_1= T_1: Recommended dose (N,P,K,S) as per FRG, 2018 (STB), T_2: T_1 + Zn_1B_1 kg ha^{-1} , T_3: T_1 + $Zn_2B_{1.5}$ kg ha^{-1}, T_4: T_1 + Zn_3B_2 kg ha^{-1} and T_5: Farmers practice (average of 10 farmers'). Among the treatment combinations, the highest green chilli yield (12.43 t ha^{-1}) and gross margin (Tk. 222520 ha^{-1}) were obtained from T_4 treatment with BARI Morich-3. The lowest green chilli yield (7.98 t ha^{-1}) having the lowest gross margin (Tk. 119000 ha^{-1}) was recorded from farmers' practices (T_5) treatment.

On farm validation of biofertilizer in different legume crops at Kushtia

An experiment was conducted at Kushtia during the Rabi season of 2019-20 to observe the effect of Rhizobial biofertilizers to the performance of lentil, chickpea and mungbean. The effect of rhizobial biofertilizers to the performance of lentil, chickpea and mungbean was found positive. The yield and gross margin was higher with rhizobium inoculated plot than other treatments.

Effect of nutrient management on the yield and storability of sweet potato in Kushtia

The experiment was conducted at Kushtia districts during the year of 2019-20 in farmer's field to observe the nutrient management of sweet potato varieties in Kushtia. Nutrient management, viz. T_1=PM @3tha^{-1}+$N_{126}P_{15}K_{115}S_8$ kg ha^{-1} (IPNS); T_2=CD @6tha^{-1}+$N_{128}P_{13}K_{118}S_{12}$ kg ha^{-1} (IPNS); T_3= Farmers' practice was used. BARI SP-8 was used. The highest yield was obtained from T_1 (20.52 t ha^{-1}).

Effect of different fertilizer management on the performance of BARI Bt brinjal

The field experiment was conducted at FSRD site, Ajoddhapur, Rangpur during 2017-18, 2018-19 and 2019-20 to find out the optimum fertilizer level for Bt Brinjal production. Soil test-based fertilizer (STB) was verified with different combination of chemical fertilizer. Six combinations of fertilizer were used for the experiment viz, T_1= STB fertilizer splitting as per recommendation (FRG, 2012), T_2= T_1 +25% NPK (splitting 5 times), T_3= T_1 +50% NPK (splitting 5 times), T_4= T_1 +75% NK (splitting 5 times), T_5= T_1 + 25% NPKS and T_6= Farmers Practices. The experiment was laid out in RCB design with 6 replications. Among the treatments, T_3 (STB fertilizer with 50% additional NPK splitting 5 times) gave maximum mean fruit yield (41.80 t ha^{-1}). The highest gross margin (Tk.534643ha^{-1}) was also found in T_3 treatment and the lowest in farmers practice.

Development of fertilizer package for bitter gourd production in charland

An experiment was conducted in the Charland of Begumganj, Ulipur, Kurigram during the *rabi* season of 2019-20 to find out the suitable fertilizer package for bitter gourd production. The experiment comprised with four treatments T_1: STB fertilizer dose, T_2: STB fertilizer dose + Liquid PGR (Biofol Super) spray 3 times, T_3: Liquid PGR (Biofol Super) spray 4 times and T_4: Farmers practice (No fertilizer). Local bitter gourd variety (ucche) was used. Among the treatment's higher Bitter gourd fruit yield (4.19 t ha^{-1}) and gross margin (Tk. 171274 ha^{-1}) was obtained from T_3 treatment, which was identical with T_2 treatment. Fruit yield was lower in both the treatment of T_1 (3.21 t ha^{-1}) and T_4 (3.26 t ha^{-1}) with later.

Effect of compound fertilezer on the growth and yield of onion

The study was conducted at Jaldhaka, Nilphamari under OFRD, BARI, Rangpur during *rabi* season of 2019-20 to find out the effect of OCP compound fertilizer and improved practice on the yield of onion funded by OCPF-BARI-ICARDA collaborative project. BARI Piaz-1 was used as the test crop. The experiment was laid out in a RCB design with three replications. Three different fertilizer managements were considered as the treatment for the trial *viz*., OCP compound fertilizer, recommended fertilizer dose and farmer's practice. The dose of OCP compound fertilizer was calculated from the recommended fertilizer dose. The highest amount of bulb (14.55 t ha^{-1}) was obtained from the OCP compound fertilizer application plot and the lower amount of bulb (10.05 t ha^{-1}) was weighted from the farmers practice. The highest gross return (Tk. 582000 ha^{-1}), gross margin (Tk. 398330 ha^{-1}) was obtained from the application OCP compound fertilizer and the lowest gross return (Tk. 402000 ha^{-1}) and gross margin (Tk. 222385 ha^{-1}) was obtained from farmer practice.

Development of fertilizer recommendation for mukhikachu in aez 11

The experiment was conducted at the farmer's field of Paba, Rajshahi during the *rabi* season of 2018-19 to find out a suitable combination of different fertilizers for mukhikachu production. The experiment was laid out in RCBD design with four fertilizer treatments viz. T_1= Soil test-based dose (FRG, 2012), T_2= 25% higher NPK of soil test base dose, T_3= 50% higher NPK of soil test base dose, and T_4=Farmers dose. Local mukhikachu variety 'Sonamukhi' was used as test crop. Among the treatment, the highest yield was obtained from T_3 (22.99 t ha^{-1}) followed by T_2 (20.27 t ha^{-1}) and T_4 (20.84 t ha^{-1}). Maximum gross return (574750Tk ha^{-1}) found in T_3 where maximum gross margin (413735 Tk ha^{-1}) and BCR (3.57) were recorded in same.

Effect of different fertilizer management on the performance of BARI bt brinjal

The experiment was conducted in the farmers field of Shibpur, Puthia, Rajshahi during the Rabi season of 2017-18, 2018-19 and 2019-20 to evaluate the effect of nutrients management packages on Bt begun cultivation and to find out a suitable combination of different fertilizers for Bt Begun production. The experiment was laid out in RCBD design with six fertilizer doses *viz*., T_1= STB fertilizer splitting as per recommendation (FRG2012), T_2= T_1+ 25% NPK (NK splitting 5 times), T_3= T_1+ 50% NPK (NK splitting 5 times), T_4= T_1+ 75% NK (NK splitting 5 times), T_5= T_1+ 25% NPKS and T_6=Farmers dose. Brinjal variety BARI Bt Begun– 4 was used as test crop. Among the treatment, the highest fruit yield was obtained from T_4 (47.66 t ha^{-1}) followed by T_3= T_1+ 50% NPK (NK splitting 5 times). Maximum gross return (Tk. 571920 ha^{-1}) found in T_4 where maximum gross margin (Tk. 388951 ha^{-1}) and BCR (3.13) were also recorded. The fertilizer dose T_4 (187-26135-8-1-1 kg ha^{-1}N-P-K-S-Zn-B, respectively) with 5 t ha^{-1} could be extensively used for BARI Bt Begun 4 production in AEZ-11.

Management of tip burn of garlic

The experiment was conducted at ARS, BARI, Bogura during 2019-2020 to study the effective control measures of tip burn of garlic. The tip burn incidence varied from 35-85%, while the highest tip burn incidence was obtained from T_1 (Three irrigation at an interval of 20 days starting after emergence) which was followed by untreated control (75 cm) and the lowest incidence was obtained from T_8 (Amistar Top @ 1 mlL^{-1} of water). The highest number (24.93) of cloves per bulb and single bulb weight (18 g) were obtained from T_6 (Soil amendment with Zn @ 3 kgha^{-1}) and the lowest of these two parameters were obtained from T_5. But control treatment resulted number of cloves per bulb and single bulb weight with 20.67 and 12.33 g, respectively. Yield varied from 7.77-10.42 t ha^{-1}, while the highest yield was recorded in T_4 (Soil amendment with boron @ 2 kg ha^{-1}) and T_7 (T_4+T_6), but control treatment gave the yield with 8.93 t ha^{-1}. The highest gross margin 363880 Tk ha^{-1} was obtained from T_4 which was followed by T_7 and the lowest gross margin Tk 178680 ha^{-1} was obtained from T_5 but control treatment showed the gross margin with Tk 259000 ha^{-1}.

Development of fertilizer package for maize at charland condition

The trial was conducted in the farmers' field of MLT site, Dhunat, Bogura during Rabi season of 2019-2020 to develop a fertilizer dose for maize under stable char land condition. The experiment was laid out in a randomized complete block design with six dispersed replications. There were five treatments i.e., T_1: STB dose, T_2: T_1 +25% extra NPK, T_3:T_1+50% extra NK, T_4: IPNS based on T_1 @5 t ha^{-1} of cowdung and T_5: Farmers Practice. Maximum grain yield (11.16 t ha^{-1}) was recorded from T_3 that was statistically similar to T_2 and T_4 and the minimum (8.43 tha^{-1}) from T_5 treatment. A similar trend was observed for stover yield. The highest gross return (Tk 231710 ha^{-1}) and gross margin (Tk 118015 ha^{-1}) were recorded from T_3 treatment and lowest gross return (Tk 175230 ha^{-1}), as well as gross margin (Tk 76910 ha^{-1}), was obtained from T_5.

Effect of ocp compound fertilizer on the growth and yield of lentil

The study was conducted at MLT site, Shibganj, Bogura during Rabi season of 2019-2020 to find out the effect of OCP compound fertilizer and improved practice on the yield of lentil with the help of OCPF-BARI-ICARDA collaborative project. BARI Moshur-8 was used as the test crop. The experiment was laid out in a RCB design with four replications. Three different fertilizer managements were considered as the treatment for the trial viz. T_1: OCP compound fertilizer, T_2: Farmer's practice and T_3:SRC recommended dose. The dose of OCP compound fertilizer was adjusted with the SRC recommended fertilizer doses. Most of the parameters were statistically significant among the different fertilizer practices. The highest amount of seed yield (1.98 t ha^{-1}) was weighted from the OCP compound fertilizer application plot and the lower amount of seed (1.14 t ha^{-1}) was weighted from the farmer practice which was identical to PRC recommended fertilizer (1.82 t/ha). Application of OCP compound fertilizer showed better performance than the improved practice and significantly increased seed yield of lentil. Upon cost and return analysis, the highest BCR (2.69) was recorded from OCP compound fertilizer treat plots (T_1) followed by PRC recommended fertilizer treated plots (T_3) and the lowest (1.94) from farmers practiced plots (T_2).

Effect of OCP compound fertilizer on the growth and yield of onion

The study was conducted at MLT site, Shibganj, Bogura during *rabi* season of 2019-2020 to find out the effect of OCP compound fertilizer and improved practice on the yield of onion with the help of OCPF-BARI-ICARDA collaborative project. BARI Piaz-4 was used as the test crop. The experiment was laid out in an RCB design with four replications. Three different fertilizer management was considered as the treatment for the trial viz. T_1: OCP compound fertilizer, T_2: Farmer's practice, and T_3:SRC recommended dose. The dose of OCP compound fertilizer was adjusted with the SRC recommended fertilizer doses. Most of the bulb parameters and yield contributing characters were statistically significant among the different fertilizer practices. The numerically higher amount of bulb (22.21 t ha^{-1}) was weighted from the OCP compound fertilizer application plot which was identical to SRC recommended fertilizer (22.95 t ha^{-1}) and the lower amount of bulb (18.67 t ha^{-1}) was weighted from the farmer practice. Upon cost and return analysis, the highest BCR (3.18) was recorded from OCP compound fertilizer treat plots (T_1) followed by SRC recommended fertilizer treated plots (T_3) and the lowest (2.62) from farmers practiced plots (T_2).The application of OCP compound fertilizer exhibited better performance over the other practices regarding bulb yield.

Effect of ocp compound fertilizer on the growth and yield of garlic

The study was conducted at MLT site, Shibganj, Bogura during Rabi season of 2019-2020 to find out the effect of OCP compound fertilizer and improved practice on the yield of garlic funded by OCPF-BARI-ICARDA collaborative project. BARI Rashun-3 was used as the test crop. The experiment was laid out in an RCB design with four replications. Three different fertilizers management was considered as the treatment for the trial viz. OCP compound fertilizer, SRC recommended dose, and farmer practice. The dose of OCP compound fertilizer was calculated from the SRC recommended dose. Most of the bulb parameters and yield contributing characters were statistically significant among the different fertilizer practices. The higher amount of bulb (10.52 t ha^{-1}) was weighted from the OCP compound fertilizer application plot which was identical to SRC recommended practice (9.14 t ha^{-1}). The lowest amount of bulb (7.43 t ha^{-1}) was weighted from the farmer practice. Application of OCP compound fertilizer and optimum fertilizer management options showed better performance over the farmers' practice regarding the bulb yield of garlic. Upon cost and return analysis, the highest BCR (3.06) was recorded from OCP compound fertilizer treat plots (T_1) followed by T_3 (3.14) and the lowest (2.65) from farmers practiced plots (T_2).

Response of potato to fertilizer at charland in Faridpur

The experiment was conducted at MLT site, Dicrir Char, Faridpur Sadar, Faridpur during the *rabi*, 2018-19 and 2019-20 to find out optimum fertilizer package for higher productivity of potato under farmers' field situation in Low Ganges River Flood Plain soil (AEZ-12). The tested variety of potato was BARI Alu-41. The five treatments were T_1 (STB)=162-30-44-25-0-0.46 kg N-P-K-S-Zn-B ha^{-1}, T_2 (T_1+2o% NPK of T_1)= 194-36-53-25-0-0.46 kg N-P-K-S-Zn-B ha^{-1}, T_3 (T_1+30% of NPK of T_1)=210-40-57-25-0-0.46 kg N-P-K-S-Zn-B ha^{-1} and T_4 (T_1+ 30% of NPKS of T_3)=225-42-61-33-0-0.46 kg N-P-K-S-Zn-B ha^{-1} and T_5 (FP)=180-40-90-15 kg N-P-K-S-Zn-B ha^{-1}. The experiment was laid out in a randomized complete block design replicating six times. The highest average tuber mean yield (29.33 t ha^{-1}) was obtained from (T_3) and the lowest yield (26.55t ha^{-1}) was accounted from T_5. In terms of cost and return, T_3 showed the highest mean gross margin (Tk 163818 ha^{-1}) and BCR (1.75).

Nutrient management for yield improvement of bt brinjal in AEZ-12

The experiment was conducted at the FSRD Site, Sholakundu, Faridpur during 2018-19 and 2019-2020 to find out optimum fertilizer packages for higher productivity of BARI Bt brinjal under farmers' field situation. The tested variety was BARI Bt Begun-3. The experiment was laid out in randomized complete block (RCB) design with six replications. Four treatments were considered as T_1 (STB)=119-15-100-19-0.5-0 kg N-P-K-S-Zn-B ha^{-1} +cow dung 10 tha^{-1}, T_2 (RD)=138-50-100-18-1.7-0 kg N-P-K-S-Zn-B ha^{-1} + cow dung 10 tha^{-1}, T_3 (T_2+ 50% of T_2)=207-75-150-27-2.7-0 kg N-P-K-S-Zn-B ha^{-1} +cow dung 10 t ha^{-1} and T_4 (FP)=225-75-125-35-2.7-1.3 kg N-P-K-S-Zn-B ha^{-1} +cow dung 05 t ha^{-1} for the trial. The treatment, T_3 (T_2+ 50% of T_2)=207-75-150-27-2.7-0 kg N-P-K-S-Zn-B ha^{-1} +cow dung 10 t ha^{-1} appeared as the best over STB fertilizer dose. T_3 gave the highest average yield (25.99 t ha^{-1}) and BCR (2.31) followed by treatment T_4.

Effect of variety and fertilizer of onion bulb production under zero tillage condition

An experiment was carried out at the farmers' field of MLT site, Jajira upazilla, Shariatpur during the rabi 2019-2020 to find out suitable variety and fertilizer dose for increasing bulb yield of onion under zero tillage condition. Six treatments i.e. T_1: BARI Piaz-1+Recommended Fertilizer Dose (RFD), T_2:BARI Piaz-1+150% RFD, T_3:BARI Piaz-1+Farmer's fertilizer dose (FFD), T_4:Local variety+Recommended Fertilizer Dose (RFD), T_5:Local variety+150% RFD, T_6:Local variety+Farmer's fertilizer dose (FFD) were used. The highest bulb yield (12.74 t ha^{-1}) was obtained from T_4 where local variety with RFD followed by T_3 (BARI Piaz-1 with FFD) were used. The highest gross return (Tk 1146600 ha^{-1}) and gross margin (Tk 842793 ha^{-1}) were accounted from T_4 due to highest yield found. The lowest gross margin (Tk

747135 ha^{-1}) was obtained from that treatment (T_5) where local variety and 150% of recommended fertilizer dose was used.

On farm of validation of biofertilizer in lentil

The experiment was conducted at MLT Site Kaliganj, Jhenidah during rabi season 2019-20 to find out the performance of bio-fertilizer for growing lentil in the farmers field. Three treatments viz. T_1=Without Rhizobium inoculant+PKSZn, T_2=With Rhizobium inoculants+PKSZn, T_3=NPKSZn were used in the experiment. PKSZn chemical fertilizers with inoculums' showed the highest (1.75 t ha^{-1}) yield of lentil followed by farmers' dose (1.63 t ha^{-1}) and this was lowest (1.42 t ha^{-1}) from PKSZn without innoculum. Highest gross return (Tk 108750 ha^{-1}), gross margin (Tk 68250 ha^{-1}) and BCR (2.69) were obtained from PKSZn chemical fertilizers with inoculums' and these were lowest from PKSZn without inoculum.

Validation of fertilizer management on fruit yield of Bt brinjal

The field experiment was conducted at Ramnagar village under Shibaloya upazila of Manikganj district during Rabi season of 2019-20 to observe the response of fertilizers on the yield performance of BARI Bt brinjal-2 in the farmers' field. The experiment was conducted in RCB design with three replications. Three fertilizer treatment combinations T_1=180-54-135-22-3-1.50 kg ha^{-1} of N-P-K-S-Zn-B+5 t ha^{-1} cow dung (STB Recommended dose+50% N-P-K), T_2=150-45-112-18-2.5-1.25 kg ha^{-1} of N-P-K-S-Zn-B+10 t ha^{-1} cow dung (STB Recommended dose+25% NPK+5 t ha^{-1} cowdung); T_3= 150-45-112-18-2.5-1.25 kg ha^{-1} of N-P-K-S-Zn-B+5 t ha^{-1} cow dung (STB Recommended dose+25% of NPKSZnB) were evaluated. Among the treatments T_2=150-45-112-18-2.5-1.25 kg ha^{-1} of N-P-K-S-Zn-B+10 t ha^{-1} of cow dung (STB Recommended dose+25% NPK 5 t ha^{-1} of cow dung) gave the highest fruit yield (28.70 t ha^{-1}), T_1=180-54-135-22-3-1.50 kg ha^{-1} of N-P-K-S-Zn-B+5 t ha^{-1} of cow dung (STB Recommended dose+50% NPK)(28.00 t ha^{-1}) and the lowest fruit yield (23.57 t ha^{-1}) was obtained from T_3=150-45-112-18-2.5-1.25 kg ha^{-1} of N-P-K-S-Zn-B+5 t ha^{-1} cow dung (STB Recommended dose+25% of NPKSZnB). Treatment T_1 was found economically profitable (BCR 2.06) than T_2 (BCR 1.89) and T_1 (BCR 1.83)

Development of fertilizer management package for onion

The trial was conducted at MLT Site, Sujanagar, Pabna during the rabi season of 2018-19 and 2019-20 to find out the optimum fertilizer package for onion cultivation. Different fertilizer management packages *viz*., T_1=Recommended fertilizer (RF) (FRG' 2018), T_2= RF +Extra 25% NPKS, T_3=RF+1.5 ton ha^{-1} rice husk ash, T_4=RF+2 ton ha^{-1} poultry manure and T_5= Farmers fertilizer package were tested on popular variety of onion (BARI Piaz-1). The application of RF+1.5 ton Ash ha^{-1} and RF+2 ton PM ha^{-1} exhibited better performance on yield attributes and bulb yield of onion. Maximum gross return and gross margin was obtained from RF+1.5 ton Ash ha^{-1} followed by RF+2 ton PM ha^{-1} and RF+extra 25% NPKS. Therefore, RF+1.5 ton ha^{-1} rice husk ash and RF+2 ton ha^{-1} poultry manure can be a good nutrient management package for onion production.

Development of fertilizer management package for garlic under zero tillage condition

The trial was conducted at MLT Site, Atghoria, Pabna during the rabi season of 2019-20 to find out the optimum fertilizer package for garlic under zero tillage condition. Different treatments *viz*., T_1=STB as FRG 2012, T_2=STB+extra 20% NPK, T_3=STB+extra 20% NK, T_4 =STB+extra 40% NK T_5=80% of STB and T_5=Farmer's practice were tested on local variety of garlic. Soil test based fertilizer plus 20% extra NPK and 40% extra NK exhibited better performance in yield contributing characters and bulb yield of garlic. The maximum economic benefit in terms of gross return and gross margin was obtained from STB plus extra 20% NPK treatment which was closely similar to STB plus extra 40% NK.

Integrated nutrient management for sunflower in coastal soil

The experiment was conducted at MLT site Amtali, Barguna during rabi season of 2018-19 & 2019-2020 to determine appropriate doses of fertilizer for sunflower production in coastal area. Three doses of fertilizer i.e. Soil test based fertilizer dose for high yield goal, IPNS with 1.5 t ha^{-1} vermi-compost and Farmers' practice were tested in the trial. The treatment, IPNS with 1.5 t ha^{-1} vermi-compost promoted plant growth and gave the highest yield (2.32 & 2.26 t ha^{-1}, respectively) in both the year.

On farm validation on biofertilizer in mungbean

An experiment was conducted at MLT site, Dumki, Patuakhali in the rabi season of 2018-19 and 2019-2020 to verify the biofertilizer effect on Mungbean under farmers field condition. Three treatments i.e. T_1=22-42-20-5 kg, P-K-S-Zn ha^{-1}, T_2=Rhizobium inoculant + 22-42-20-5 kg, P-K-S-Zn ha^{-1} and T_3=50-22-42-20-5 kg, N-P-K-S-Zn ha^{-1}. The highest seed yield (1.60 t ha^{-1}) was obtained by using T_3=50-22-42-20-5 kg, N-P-K-S-Zn ha^{-1}.followed by T_2=Rhizobium inoculant 22-42-20-5 kg, P-K-S-Zn ha^{-1} treatment (1.42 t ha^{-1}).

Effect of fertilizer doses with elevated levels of potassium on soil salinity and yield of transplanted maize

The experiment was conducted at MLT site Kuakata, Patuakhali during the Robi season 2018-19 & 2019-20 to find out the effect of different fertilizer doses with elevated levels of potassium for maize cultivation in saline coastal region under farmers field condition. Sixteen days old poly bag BARI Hybrid maize-9 seedlings were tested to observe the performance. There were four different fertilizer doses T_1: Soil test based fertilizer (STB) dose, T_2: STB+50% K T_3: Fertilizer Recommendation Guide (FRG' 2018) +50% K, T_4: Farmer's Practice (FP)+50% K. Elevated level of potassium showed positive effect on the yield of maize in coastal region in both the years. The highest grain yield (8.79 t/ha) was observed in T_3 i.e. 229-47-167-35 kg ha^{-1} NPKS fertilizer doses and the lowest grain yield was obtained from T_1 i.e. 180-40-135-25 NPKS fertilizer doses (7.78 t ha^{-1}).

On farm validation of biofertilizer in groundnut at Jamalpur region

The experiment was conducted in the farmers' field of Naovanghar Char, Jamalpur during *rabi* season 2019-20. The maximum yield of nut (2.36 t ha^{-1}) was found from T_2 which was followed by T_3 treatment and the minimum (2.0 t ha^{-1}) from T_1 treatment. The higher gross return (Tk 165200 ha^{-1}) and gross margin (Tk 87880 ha^{-1}) were observed from T_2 treatment due to its higher yield. The lowest gross return (Tk. 140000 ha^{-1}) and gross margin (Tk. 63986 ha^{-1}) were found from T_1 treatment due to its lower yield.

Effect of fertilizer dose and variety on the yield of chili at charland

An experiment was conducted in the farmers' field of MLT site, Bhuapur, Tangail during Rabi season of 2018-19 and 2019-20 to find out the suitable fertilizer dose for chilli and to increase productivity and economic return of farmers. The experiment comprised with five treatment T_1= STB as per FRG, 2012, T_2 = T_1 +15% extra NPK, T_3 =T_1 + 30% extra NPK, T_4 =T_1 + 45% extra NPK, and T_5= Farmers practice and two chilli variety (V_1 = BARI Morich-2 and V_2 = Farmers' variety). Among the treatment combinations the highest average green chilli yield of two consecutive years (12.83 t ha^{-1}) and gross margin (Tk. 471432 ha^{-1}) was obtained from soil test-based fertilizer dose with chilli var. BARI Morich-2. The lowest green chilli yield (8.80 t ha^{-1}) with the lowest gross margin (Tk 297199 ha^{-1}) was recorded from farmers' variety with T_5 treatment combination.

Validation of biofertilizer of lentil

A field trial was conducted at the Farming Systems Research and Development site (FSRD), Faridpur during the *rabi* 2018-19 and 2019-20 to find out the effects of rhizobial biofertilizers on the performance of lentil. The trial was laid out in RCB design with four dispersed replications. The lentil variety BARI Masur-6 and peat based rhizobium strain (BARI RLc-104) were used for the experiment. Unit plot size was 6 m × 5 m. Three treatment combinations viz., T_1 (without Rhizobium inoculant+ P_{22} K_{42} S_{20} Zn_5 kg ha^{-1}), T_2 (with Rhizobium inoculant+ P_{22} K_{42} S_{20} Zn_5 kg ha^{-1}) and T_3 ($N_{50}P_{22}$ K_{42} S_{20} Zn_5 kg ha^{-1}) were considered in this regard. From the average of two years result, the higher seed yield was obtained (1.63 t ha^{-1}) where Rhizobium inoculant along with P_{22} K_{42} S_{20} Zn_5 kg ha^{-1} was used (T_2). Benefit cost ratio was also higher in T_2 treatment (2.62) as well as gross margin (Tk 67640 ha^{-1}) over those of other two treatments.

Effect of different fertilizer management packages on yield of soybean in chandpur

The fertilizer trial was carried out in the Bakhorpur Gobinda village of Chandpur Sadar upazilla of Chandpur district during the *rabi* season of 2019-20 with a view to test the performance of BARI soybean -5 in farmers field in existing cropping pattern with different fertilizer package with farmers own practice in that area. There was no statistically significant difference between the yield of three fertilizer package. Numerically the higher seed yield of BARI Soybean-5 was 1793.7 Kg ha^{-1}, which produced more gross return and gross margin than STB and farmers practice. Farmers practice gave numerically lower yield, gross return and gross margin.

Base line survey for farmer livelihood improvement at farming system research and development, tanore, Rajshahi

A base line survey was undertaken to know the existing farming practices of the farmers of Chanduria union, Tanore, Rajshahi. Survey covered crop, livestock, fish, homestead, agro forestry systems with data pertaining to 30 farmers from two villages of the union. Data refer to the input output details and other socio-economic characteristics of farm households in the crop year 2018-2019. Random sampling technique has been used for collecting data. The result of the baseline survey showed that out of 30 sample farmers; landless (less than 0.02 ha), marginal (0.021–0.2 ha), small (0.21–1 ha), medium (1–3 ha) and large (>3 ha) farmer numbers were 4, 9, 28, 8 and 1, respectively. Four types of major farming systems exist in the Farming System Research and Development (FSRD) site of BARI. Among the four farming systems, the highest number of farmers were under Crop+Livestock+Poultry system followed by Crop + Livestock + Poultry + Fisheries, Crop + Poultry and Crop + Livestock+ Poultry + Agroforestry. Average farm size was the highest under Crop + Livestock + Poultry + Fisheries + Agroforestry system and lowest under Crop + Poultry farming systems. About 87 percent of lands were used under high yielding variety crop whereas only 13 percent land use under local variety. There were 7 major cropping patterns are observed in the site. The main cropping pattern was Boro–Fallow–T. Aman rice followed by Potato–Maize–T. Aman, Potato–Jute–T. Aman, year-round vegetable, Potato–Boro rice–T. Aman, Banana and sugarcane. Out of seven cropping patterns, net returns was the highest in banana cultivation (Tk. 159,767 ha-1) followed by Vegetables–Vegetables–Vegetables (Tk. 117,996 ha-1), Potato–Jute–T. Aman (Tk.115,590 ha-1), Potato–Maize–T. Aman (Tk. 10,610 ha-1), Potato–Boro–T. Aman (102,898 ha-1), Sugarcane (Tk 59,036 ha-1) and Boro-Fallow-T. Aman rice (Tk. 31,352 ha-1). Average per farm total net return were from livestock Tk.12,132 and from poultry Tk. 392 for the year 2011–2012. Out of 50 sample farmers, 10 farmers culture fishes in the Farming System Research and Development site. On an average, per farm total gross margin was Tk. 2680 containing telapia Tk. 620, carps Tk.600 and other fish Tk.1460. Income was categorized by crop, livestock, fisheries, poultry, homestead, agro forestry, off farm and non-farm system. In case of landless and marginal farm, non-farm income was higher compared to farm income. Contrary, in case of small, medium and large farm, farm income was higher compared to non-farm income. Farming constraints that were identified include lack of knowledge about new crop variety and technology was the main problems of the farmer followed by high price of inputs, lack of knowledge about fish feed and pond management, lack of quality seeds/fingerlings/duck links, lack of credit facility, lack of knowledge about homestead vegetables production, lack of knowledge about vaccination, deworming, feed of livestock and poultry, insect/pests/weeds and lack of money for buying inputs.

Fertilizer management practices of existing mixed and Intercropping systems in FSRD site of Faridpur

The study was conducted at the FSRD site Sholakundu, Faridpur district during January-February, 2020. The objectives were to identify the existing multiple cropping system, their management practices and constraints of production. Inter, mixed and relay cropping were denoted by the sign of (+), (/) and (//) respectively. A total of 50 farmers, who practiced multiple cropping were selected randomly. The required data were collected with the help of pre–designed and pre–tested interview schedule. The study revealed that Lentil and Mustard mixed cropping was practiced mainly under Lentil/Mustard–Jute-T. Aman cropping pattern in medium high land in Sholakundu, Faridpur. It was noticed that farmers did not apply any organic manure in this system but less amount of chemical fertilizer was applied at the rate of 55, 72, 38 and 53 kg of Urea, TSP, MOP and Gypsum per hectare, respectively. All fertilizers were incorporated in soil during final land preparation with broadcast method. They did not use Urea as top dress in this cropping system. Wheat-Jute//B. Aman was another dominant relay cropping system in Faridpur. Farmers applied 140, 80, 25 and 42 kg of Urea, TSP, MOP and Gypsum per hectare, respectively in relay cropping. No organic manure was found to be applied in that cropping system. One third of Urea and all other fertilizer were broadcast and incorporated during final land preparation. First top dressing of Urea was done during 25–30 DAS of Jute and second top dressing of Urea was applied during 30-40 DAS of B. Aman.

Identification of best agricultural practices and cropping patterns in selected areas of Mymensingh district

The study was carried out in two selected villages namely Nouder and Akhrael under the upazila of Trishal in Mymensingh district with view to identify the best agricultural practices and cropping pattern during December to February, 2020. In study area the net cropped area (NCA) was 24150 ha and productivity of crop is 240%. The most dominant cropping pattern Boro-Fallow-T. Aman occupied 58% of net cropped area (NCA). Boro- T. Aus-T. Aman cropping pattern ranked the second position which covered 13% of NCA. A total of 33 cropping patterns were identified in the Trishal upazila of Mymensingh district under this investigation. The study revealed that the average homestead area was found 0.05 ha. Per household average single, double and triple cropped area was estimated at 0.04ha, 0.21ha and 0.17ha, respectively. It was reported that after the rice cultivation the bottle gourd (26.7%), cucumber (53.3%), aroid (43.3%), lades finger (40%), bean (20%) brinjal (13.3%), lalshak (10%), tomato(13.3%), potato(23.3%),bitter gourd (18.3%) cabbage (15%), steam amaranth (10%) and chili (30%)were found as the major vegetables crops. Considering the Boro-Fallow-T. Aman rice cropping pattern, the production cost, gross return, net return and BCR were estimated Tk.155154, Tk.207172, Tk.52288 and 1.34 respectively. On the other hand in Boro- T.Aus T.Aman rice cropping pattern, the production cost, gross return, net return and BCR were estimated Tk.223293, Tk.295832, Tk.72539 and 1.32 respectively while in Vegetables-Vegetables-Vegetables cropping pattern, the production cost, gross return, net return and BCR were estimated Tk.293671, Tk.635616, Tk.341945 and 2.16 respectively in the study area. The study also revealed that benefit cost ratio of vegetables is greater than rice production. Besides, the portion of double -rice area could be brought under Mustard-Boro-T. Aman or Boro-Jute-T. Aman and triple crop area could be brought under Mustard-Boro-T. Aus-T. Aman. Suitable vegetables might be grown on floating bed system in wet season. So, initiative should be taken to increase productivity of exclusive rice-based cropping pattern along with recommended crop management practices in the study area.

Adoption of some BARI released major winter vegetables In Kishoreganj districts

The study assessed the level of adoption and profitability of major winter brinjal, tomato and radish BARI developed varieties at farm level. Data were collected from total 90 randomly selected farmers of Pakundia and Karimganj upazila of Kishoreganj district. The results indicated that BARI mula-1 was highly adopted variety (56%) followed by BARI begun-8 (20%) and BARI tomato variety (10%). The adoption level of ploughing, use of manure, time of seed sowing and seedling age was found high, whereas Urea, TSP and MoP fertilizer use were low. Total cost of production of brinjal, tomato and radish were Tk 344270, 330434 and 177465 per hectare whereas Tk 451929, 456259 and 178017 were gross margin respectively. Non-availability of BARI variety seed in the market, unknown of BARI to farmers and lower yield of BARI variety than commercial hybrids were the major constraints for the adoption of BARI variety.

Cereal Crops

Adaptive trials with barley advance lines in barind areas

The trial was conducted at the farmer’s field of FSRD site, Basantapur, Godagari, Rajshahi under AEZ 26 during Rabi 2019-20 with a view to select high yielding barley advance lines for drought areas. The trial consists of three advance lines viz. BHL-25, BHL-27 and BHL-29 and three barley varieties namely BARI Barley-6, BARI Barley-7, BARI Barley-8 were used as check. The genotypes were evaluated for yield and yield components like Days to flowering, Days to maturity, plant height, No. of spike m^{-2}, thousand grain weight (TGW) and grain yield with the close supervision of OFRD, Barind Station, Rajshahi. Out of five barley varieties/lines BHL-27 gave the highest grain yield (2.19 t ha^{-1}) followed by BHL-25 (1.99 t ha^{-1}). The lowest grain yield was produced by BARI Barley-7(1.84 t ha^{-1}). Considering the yield and yield contributing characters BHL-27 is the suitable one for Barley production in High Barind Tract.

Adaptive trail with BARI kaon varieties in Barind areas

A field trial was conducted in the farmer's field at Basantapur, Godagari, Rajshahiunder AEZ 26 during 2019-2020 cropping season to disseminate and to popularize BARI kaon varieties among the farmers at barind area. Three varieties of kaon viz. BARI Kaon-1, BARI Kaon-2 and BARI Kaon-3 were tested in farmer's field. Among the tested varieties BARI Kaon-2 gave maximum grain yield (2.51 t ha^{-1}) and BARI Kaon-1 gave minimum grain yield (1.85 t ha^{-1}).

On-farm trial of BARI developed foxtail millet variety in mlt site Munshiganj

The experiment was conducted in the farmers' field at Shiloy of MLT site, Munshiganj during 2019-20 to evaluate the performance of BARI developed high yielding varieties of foxtail millet by randomized complete block design with four replications. No disease and insect infestation was observed in foxtail millet. The higher yield of foxtail millet was calculated from BARI Kaon-2 (2.95 t ha^{-1}) followed by BARI Kaon-1 (2.31 t ha^{-1}). Farmers were interested to produce BARI Kaon-2 for its higher yield.

Effect of planting geometry on yield of maize at hill valleys of Bandarban

The experiment was conducted to evaluate the effect of plant geometry (row to row and plant to plant spacing: 60 × 25, 50 × 15, 50 × 20, 50 × 25, 40 × 15, 40 × 20, and 40 × 25 cm) on growth and yield ofmaize at Bakichara hill valleys in Bandarban under AEZ-29during the Rabi season, 2019-2020. Spacing influenced seeds per cob, thousand grain weight and yield of maize. As spacing increases, yield contributing characters tend to increase to certain spacing, then decrease with the increasing of spacing. The highest seed per cob (550.59) and grain yield (9.62 t ha-1) was found at50 cm × 25 cm spacing followed by (60 × 25, 40 × 25, 50 × 20, 50 × 15, 40 × 20 and 40 × 15) cm, respectively.

Intercropping of bush bean with maize in hill valleys of bandarban

A field experiment was conducted to evaluate the suitability and economic performance of BARI Bush bean intercrop with BARI Hybrid Maize at farmer's field of hill valleys in Bandarban under AEZ 29 during the Rabi season, 2019-2020. Two treatments viz. T_1: Sole Maize and T_2: Maize+Bush bean was used for the experiment. The results revealed that Maize + Bushbean combination did not influence yield and yield contributing characters of maize as compared to sole maize. The intercropping combination performed better in terms of maize equivalent yield, gross return and benefit cost ratio (BCR) over sole crops.

Evaluation of selected promising maize hybrids for saline areas

The experiment was conducted at Amtoli, BorgunaunderAEZ-13during the Rabi season of 2019-20 in coastal saline environment under farmers' field condition, to evaluate the performance of hybrids maize and to select saline tolerant desirable best one(s). Ten maize genotypes i.e. CML 433, CML 451, BIL 79, KI 21, BMZ 4, Pinacle 12, Pinacle20, BIL 65, 981, Don 111along with two varieties BHM 7, BHM 16 were evaluated. Among the genotypes, the BIL 79 produced the highest grain yield (7.7 t ha^{-1}) followed by Don 111 (7.61 t ha^{-1}), CML 433(6.90 t ha^{-1}), CML 451 (6.71 t ha^{-1}) and BHM 16 (6.69 t ha^{-1}).

Validation of promising selected proso millet lines under rainfed condition

An adaptive trial was conducted at FSRD site Basantapur, Godagari, Rajshahi and Saghata, Gaibandha during Rabi season 2019-2020 to evaluate the better performance of advanced lines and to popularize among the farmers under on-farm situation in different AEZ's. A total of ten promising advance lines of Proso millet along with BARI Cheen-1 were tested. Ten advanced lines; BD-791, BD-1393, BD-1398, BD-1399, BD-1402, BD-1436, BD-1446, BD-1454, BD-1486, BD-1488 and BARI Cheena-1were used in two locations. All the tested lines produced a satisfactory yield. Among them, the average highest yield over the location was recorded from BD-1454 (3.45 t ha^{-1}) and the lowest from BD-791 (3.05 t ha^{-1})in Saghata, Gaibandha where the tested line BD-1402 gave maximum grain yield (2.48 t ha^{-1}) and BD-1393 line gave minimum grain yield (2.07 t ha^{-1}) at FSRD site Basantapur, Godagari, Rajshahi.

On-farm trial of BARI developed maize hybrids

An adaptive trial was conducted Cumilla, Tangail, Faridpur, Rajbari, Kushtia, Jhenidah, Bandarban and Rajshahi during the year of 2019-20to evaluate the performance of BARI Hybrid Maize (BHM) varieties with two imported varieties and to popularize among the farmers under on-farm situation in different AEZ's. A total of seven BARI released hybrid maize varieties viz., ., T_1= BARI Hybrid Maize-7, T_2 = BARI Hybrid Maize-9, T_3= BARI Hybrid Maize-13, T_4= BARI Hybrid Maize-14, T_5= BARI Hybrid Maize-15, T_6= BARI Hybrid Maize-16, T_7= BARI Hybrid Maize-17 and addition two imported varieties like Pacific 981, Don 111 were used in eight locations. The imported variety Hiramon was used as a check in Kushtia only. Among the BARI Hybrid Maize varieties, BHM-16 (9.60t ha^{-1}) gave the highest grain yield followed by BHM-9 (9.40 t ha^{-1}), BHM-15 (8.94t ha^{-1}), BHM-17 (8.88 t ha^{-1}), BHM-13 (8.76 t ha-^{1}), BHM-7 (8.61 t ha^{-1}), respectively and BHM-14 (8.53 t ha^{-1}) gave the lowest grain yield. The range of grain yield was 8.53 to 9.60 t ha^{-1}. Among the imported varieties, Hiramon produced maximum (11.68 t ha^{-1}) grain yield followed by Don 111 and P-981. Among the locations, the highest grain yield was obtained from Cumilla followed by Kushtia, Tangail, Faridpur, Bandarban, Jhenidah and Rajshahi. On the basis of benefit the highest benefit cost and ratio was obtained from BHM-16 (2.41) followed by BHM-9(2.28), Pacific 981(1.95), Don 111 (1.86), BHM-7 (2.16), BHM-17(2.14) and the lowest from BHM-15 (1.67).

Horticultural Crops

On-farm trial of BARI developed eggplant varieties at Manikganj

The adaptive trial was conducted at Boinna Prashad village under Ghior upazila of Manikganj district during Rabi season of 2019-20 to evaluate the performance of BARI released eggplant varieties in the farmers' field. Four BARI varieties *viz*., BARI Begun-4, BARI Begun-6, BARI Begun-8, BARI Begun-10 and a local variety (Uttara) as check were evaluated in the study. The experiment was conducted in RCB design with 6 dispersed replications. Out of the tested varieties, BARI Begun-4 (31.17 t ha^{-1}) and BARI Begun-6 (25.00 t ha^{-1}) gave higher yield than other BARI varieties viz. BARI Begun-8 (18.00 t ha^{-1}) and BARI Begun-10 (17.00 t ha^{-1}). BSFB infestation was the main constraint to achieve higher yield. Higher gross margin (Tk. 185020.00 ha^{-1}) was also obtained from BARI Begun-4.

On-farm trail of BARI developed hybrid eggplant variety

An on-farm trial was conducted at Manikganj and Cumilla during Rabi season of 2019-20 to evaluate the performance of BARI developed hybrid eggplant varieties and to popularize the varieties among the farmers. At Manikganj, BARI Hybrid Begun-4 against Lalteer Hybrid begun and at Cumilla, BARI Hybrid Begun-4, BARI developed hybrid line 13×12 and a farmer's variety (Black ball hybrid) as check were evaluated. In the farmers field of Manikganj, Lalteer Hybrid (38.60 t ha^{-1}) gave 16.96% higher yield than BARI Hybrid Begun-4 (33.00 t ha^{-1}). At Cumillla, BARI Hybrid Begun-4 gave higher marketable yield (27.6 t ha^{-1}) followed by BARI developed hybrid line 13×12 (26.4 t ha^{-1}) and the lowest in Black Ball hybrid (21.3 t ha^{-1}).

On-farm trial of BARI winter bottle gourd variety

The trial was conducted at Jashore, Satkhira, Noakhali and Patuakhali during Rabi season of 2019-20 to evaluate the performance of BARI developed high yielding winter bottle gourd variety in the farmer's field. BARI Lau-5 and a farmer's variety as check were used in this study at Jashore, Satkhira, Noakhali whereas BARI Lau-4 with a farmer's variety as check were used. The experiment was laid out in Randomized Complete Block design with six dispersed replications. BARI Lau-4 gave higher yield (5.96 to 63.33 t ha^{-1}) compared to farmers' variety (26.65 to 60.39 t ha^{-1}). BARI Lau-5 (50.20 t ha^{-1}) at Jashore produced 19.80% higher yield than farmers' variety (41.90 t ha^{-1}). The maximum gross margin was also obtained from BARI varieties all the tested locations.

On-farm trial of BARI summer bottle gourd variety

The experiment was conducted at Amanogonj and West Al-Amin under Subarnachar upazilla in Noakhali district (AEZ 18f) during *Kharif* season of 2020 to evaluate the performance of BARI summer Bottle gourd variety at farmers' field in non-saline condition (next to homestead). Two varieties of bottle gourd *viz*., BARI Lau-4 and farmers' variety (Martin) check were used in this trial. Both the varieties produced higher and statistically similar yield in Kharif season. The fruit yield was in both the varieties. BARI Lau-4 produced (40.76 t ha^{-1}) and farmers' variety (Martin) gave (39.98 t ha^{-1}). The highest gross margin (Tk. 333173.00 ha $^{-1}$) was found from BARI Lau-4 than farmers variety (Tk. 321473.00 ha $^{-1}$).

On-farm trial of BARI developed hybrid pumpkin variety

The trial on pumpkin varieties were conducted at Cumilla, Manikganj and Mymensingh during *rabi* season of 2019-20 to evaluate the performance of BARI developed pumpkin varieties in the farmers' field. BARI developed two open pollinated varieties viz. BARI Mistikumra-1, BARI Mistikumra-2 and three hybrid sweet gourd varieties viz. BARI Hybrid Mistikumra-1, BARI Hybrid Mistikumra-2, BARI Hybrid Mistikumra-3 were tested against farmers' variety as check in different locations. The experiment was laid out in RCB design with six dispersed replications. Farmers' variety Hybrid Mistikumra-Asha gave higher yield (23.43 t ha^{-1}) compared to the BARI hybrid varieties at Cumilla. The yield performance of BARI Hybrid Mistikumra-1 appeared to be promising at Manikganj. BARI Hybrid Mistikumra-1(37.27 t ha^{-1}) produced about 18 to 29% higher yield than BARI Mistikumra-1 (31.60 t ha^{-1}) and BARI Mistikumra-2 (29.09 t ha^{-1}). The lowest yield was obtained from local variety (25.00t ha^{-1}).The yield performance of BARI Hybrid Mistikumra-3 appeared to be promising producing highest yield 34.84 t ha^{-1} over the check variety (28.89 t ha^{-1}) at Mymensingh.

On-farm trial of BARI developed bitter gourd variety

The experiment was conducted at farmer's field during *Kharif*-II season of 2019 at Jashore and *Kharif*-I season of 2020 at Manikganj to evaluate the yield performance of BARI bitter gourd varieties viz. BARI Korola-1, BARI Korola-2, BARI Korola-3 and BARI Korola-4 against farmers' variety. The experiment was laid out in RCBD with six dispersed replications. The yield of BARI Korola-2 ranged from 9.06 to 14.75 t ha^{-1} in the tested locations. At Manikganj, BARI Korola-1 (19.75 t ha^{-1}) produced 34 and 68% higher yield than BARI Korola-2 (14.75 t ha^{-1}) and farmers variety (11.75 t ha^{-1}), respectively. In the farmers' field of Jashore, local variety Goj Korola (9.78 t ha^{-1}) produced 6, 8 and 15% higher yield compared to BARI Korola-4 (8.56 t ha^{-1}), BARI Korola-3 (9.06 t ha^{-1}) and BARI Korola-2 (9.24 t ha^{-1}), respectively.

On-farm trial of BARI developed country bean variety

A field experiment was carried out at Sylhet and Pabna during *rabi* season of 2019-20 to evaluate the performance of BARI developed country bean varieties and to popularize the varieties among the farmers. BARI Shim-6 in Shim-6 at Sylhet; BARI Sheem-9 and BARI Shim-10 were evaluated at Pabna against local varieties grown in the tested locations. The trial was laid out in RCB design with six dispersed replications. The local cultivar Goalgadda produced higher pod yield (14.11 t ha^{-1}) than BARI Shim-6 (10.97 t ha^{-1}) with maximum gross margin Tk. 159840 $ha^{-1}$and Tk. 75100 ha^{-1}, respectively. BARI Shim-10 gave significantly higher fruit (15.64 t ha^{-1}) over BARI Shim-9 (12.59 t ha^{-1}) and local variety (14.85 t ha^{-1}). The highest gross margin (Tk.54884 ha^{-1}) was also obtained from BARI Shim-10.

On-farm adaptive trial of BARI developed stem amaranth variety at Manikganj

The trial was conducted at Boinna Prashad village under Ghior Upazila of Manikganj district during

Kharif-I season of 2020 to evaluate the performance of BARI released stem amaranth variety in the farmers' field. BARI variety viz. BARI Danta-1 was tested with a local variety as check in the study. The experiment was conducted in RCB design with three dispersed replications. BARI Danta-1gave 8% higher yield (33.07 t ha^{-1}) than local variety (30.66 t ha^{-1}). Higher gross margin (Tk. 94290.00 ha^{-1}) was also obtained from BARI Danta-1 than farmers' variety (Tk.84650.00 ha^{-1}).

On-farm adaptive trial of BARI developed okra variety

The on-farm trial was conducted at Cumilla during *Kharif* season of 2019 and Pabna during *Kharif* season of 2020 to evaluate the performance of BARI Dherosh-2 against farmers' variety as check. The experiment was laid out in RCB design with six dispersed replications. BARI Dhesosh-2 produced higher marketable yield 10.13 and 17.26 t ha^{-1} at Cumilla and Pabna, respectively whereas local variety gave 9.3 and 12.50 t ha^{-1}. BARI Dherosh-2 was resistant to YVMV in the farmers' field at Pabna but 10.2% infestation was recorded at Cumilla compared to the local variety (9.7%). Higher gross margin was also obtained from BARI Dherosh-2 at both the tested locations.

ON-farm trial of BARI developed winter tomato varieties

The trial was conducted at Manikganj, Tangail, Narsingdi, Rajshahi and Khulna during *rabi* season of 2019-20 to evaluate the performance of BARI developed winter tomato varieties. Eight BARI Tomato varieties viz. BARI Tomato-14, BARI Tomato-15, BARI Tomato-16, BARI Tomato-17, BARI Tomato-18, BARI Tomato-19, BARI Tomato-20 and BARI Tomato-21 were evaluated against farmer's varieties as check grown in different locations in the study. BARI developed tomato varieties performed better in different locations. The highest fruit yield (82.40 t ha^{-1}) was recorded from BARI Tomato-14 and the lowest (60.60 t ha^{-1}) from BARI Tomato-19 at Tangail. BARI Tomato-14 and BARI Tomato-17 produced higher and similar yields (38.32 t ha^{-1}) in the farmers' field at Manikganj than BARI Tomato-15 (35.57 t ha^{-1}), BARI Tomato-18 (34.73 tha^{-1}), BARI Tomato-16 (28.32t ha^{-1}) and farmers' variety produced the lowest yield (29.07 t ha^{-1}). BARI Tomato-17 (84.67 t ha^{-1}) performed the best at Narsingdi while BARI Tomato-17 gave the highest marketable yield (64.81 t ha^{-1}) followed by BARI Tomato- 19 (61.47 t ha^{-1}) at Rajshahi. In the farmer's field of Khulna, local hybrid Surakha produced significantly higher yield (53.44 t ha^{-1}) followed by BARI Tomato-14 (51.97 t ha^{-1}), BARI Tomato-17 (43.59 t ha^{-1}), BARI Tomato-18 (40.54 t ha^{-1}) and BARI Tomato-19 (36.14 t ha^{-1}). Farmers' variety produced lower yields (29.07 to 45.00 t ha^{-1}) at all the tested locations. Higher gross margin was obtained from BARI winter tomato varieties in all locations except Khulna.

ON-farm trial of BARI developed winter tomato varieties

The trial was conducted at Cumilla, Patuakhali, Noakhali, Bandarban and Faridpur during Rabi season of 2019-20 to evaluate the performance of BARI developed winter tomato varieties. Four BARI developed Tomato varieties *viz*., BARI Tomato-18, BARI Tomato-19, BARI Tomato-20 and BARI Tomato-21 were tested against farmers' variety as check. The experiment was laid out in RCB design with six dispersed replications. Tomato varieties showed significant variation in number of fruit $plant^{-1}$, individual fruit weight (g) and fruit yield per hectare in different locations. The yield of BARI Tomato-18 ranged from 72.33 to 72.83 t ha^{-1} at Patuakhali. BARI Tomato-19 performed better at Patuakhali (60.00 to 64.00 t ha^{-1}) followed by Noakhali (59.13 t ha^{-1}), Cumilla (58.50 t ha^{-1}) and the lowest at Bandarban (55.64 t ha^{-1}). At Bandarban, BARI Tomato-20 produced higher yields (70.93 t ha^{-1}) followed by Cumilla (48.70 t ha^{-1}), Noakhali (47.90 t ha^{-1}) but lower at Patuakhali (39.33 to 42.33 t ha^{-1}). BARI Tomato-21 gave higher yield at Noakhali (59.78 t ha^{-1}) followed by Bandarban (59.78 t ha^{-1}) and the lowest at Cumilla (56.98 t ha^{-1}). Farmers' variety gave statistically similar yields compared to BARI varieties at Cumilla (51.60 t ha^{-1}) and Noakhali (52.33 t ha^{-1}) but differ significantly at two locations of Patuakhali (67.00 to 69.76 t ha^{-1}) and Bandarban (37.47 t ha^{-1}).

On-farm trial of BARI developed summer hybrid tomato varieties

The on-farm trial was conducted at Subarnachar upazila of Noakhali district belong to medium high land during *Kharif* season of 2019 to evaluate the performance of BARI developed summer hybrid tomato varieties. Three BARI hybrid varieties *viz*., BARI Hybrid Tomato-8, BARI Hybrid Tomato-10 and BARI Hybrid Tomato-11 were evaluated in the study. Number of fruits plant^{-1} and individual fruit weight differ statistically among the varieties. The highest fruit bearing was observed in BARI Hybrid Tomato-8 (25.30) followed by BARI Hybrid Tomato-10 (22.40) and the lowest in BARI Hybrid Tomato-11(18.60). Fruit size of BARI Hybrid Tomato-11(59.15g) was much higher than BARI Hybrid Tomato-10 (49.67g) and BARI Hybrid Tomato-8 (46.60g). BARI Hybrid Tomato-8 produced higher fruit yield (42.26 tha^{-1}) which was statistically at par with BARI Hybrid Tomato-11(39.394 tha^{-1}) and BARI Hybrid Tomato-10 (38.93 tha^{-1}). Higher gross margin was also recorded in BARI Hybrid Tomato-8 (Tk. 1564000.00 ha^{-1}) compared to BARI Hybrid Tomato-11 (Tk. 1348925.00 ha^{-1}) and BARI Hybrid Tomato-10 (Tk. 1314250.00 ha^{-1}).

On-farm trial of BARI developed winter hybrid tomato varieties

The field experiment was conducted at Khulna and Manikganj during *rabi* season of 2019-20 to evaluate the performance of BARI winter hybrid tomato varieties and to popularize the varieties among the farmers. Two BARI hybrid tomato varieties viz. BARI Hybrid Tomato-5 and BARI Hybrid Tomato-9 were evaluated against local hybrid varieties in the study. BARI Hybrid Tomato-5 produced higher yield at Khulna (93.68 t ha^{-1}) than Manikganj (52.56 t ha^{-1}). BARI Hybrid Tomato-9 also performed better at Khulna (82.63 t ha^{-1}) whereas lower yield was recorded at Manikganj (45.39 t ha^{-1}). At Khulna, local hybrid tomato produced lower yield (82.27 t ha^{-1}) than BARI varieties but farmers variety (Unnayan hybrid) produced higher yield (57.89 t ha^{-1}) which was statistically at par with BARI winter hybrid Tomato-9 (45.39 t ha^{-1}) in the farmer's field of Manikganj. BARI Hybrid Tomato varieties provided higher gross margin at both the locations.

On-farm trial of BARI released capsicum varieties

The trial was conducted at the FSRD site Atia, Tangail in Rabi season of 2019-20 to evaluate the performance of BARI released capsicum varieties in the farmers' field. BARI released two capsicum varieties *viz*., BARI Misti Morich-1, BARI Misti Morich-2 and locally available capsicum variety were evaluated in the study. The experiment was conducted in RCB design with three replications. The highest fruit yield (18.21 t ha^{-1}) was recorded in BARI Misti Morich-2 and it differs statistically with farmers' variety (16.20 t ha^{-1}) and BARI Misti Morich-1 (14.20 t ha^{-1}) producing the lowest yield. The highest gross margin Tk. 1662475.00 ha^{-1} was also obtained from variety BARI Misti Morich-2.

On-farm trial of BARI gladiolus varieties at Tangail

The experiment was conducted in the farmers' field at the FSRD site, Atia, Delduar, Tangail during *rabi* season of 2018-2019 and 2019-2020 to evaluate the performance of BARI released gladiolus varieties and to popularize the varieties among the farmers of Tangail region. BARI developed three varieties of gladiolus viz. BARI Gladiolus-3, BARI Gladiolus-4, and BARI Gladiolus-5 was tested. The experiment was laid out in RCB design with three replications. BARI Gladiolus-4 performed better in terms of spike production and economic return. The highest number of spike per hectare (185000 nos.) was obtained from BARI Gladious-4 and lower was in BARI Gladious-5 (178333 nos.). The highest gross return (Tk. 1666000 ha^{-1}) and gross margin (Tk. 762331 ha^{-1}) was also recorded in BARI Gladiolus-4.

Spices Crops

On farm verification trial of garlic variety

The experiment was conducted at MLT site Bauphal, Kuakata, Bhola Sadar and Tangail during rabi season of 2019-20 with different types of BARI released Garlic varieties, e.g: BARI Rosun-1, BARI Rosun-2, BARI Rosun-3, BARI Rosun-4 and Local Rosun, to observe their performance in farmers' field. The trial was laid out in RCB design with three replications. Among the varieties at both locations Bauphal and Kuakata BARI Rosun-3 gave highest yield (5.06 t ha^{-1}) and (4.79 t ha^{-1}) respectively. Local Rosun gave the lowest seed yield (4.07 t ha^{-1} and 3.99 t ha^{-1}) at both locations. In Bhola Sadar, BARI Rosun-4 gave highest yield (5.4 t ha^{-1}) followed by Local Rosun (5.1 t ha^{-1}) and

BARI Rasun-2 gave lowest yield (3.9 t ha^{-1}). In Tangail, BARI Rashun-4 produced the highest bulb yield (8.58 t ha^{-1}) followed by BARI Rashun-1 (7.38 t ha $^{-1}$) and the lowest in local variety (7.01 t ha^{-1}).

On farm trial of turmeric varieties in Kishoreganj

On farm trial of turmeric varieties were conducted at the farmers' field of Binatti and Satarpur union of Kishoreganj sadar and Karimganj upazilla under Kishoreganj district during *rabi* season 2019-20 to examine a suitable turmeric variety for the area. Two BARI developed varieties such as BARI Halud-4, BARI Halud-5 and local variety were tested. The highest yield was found from BARI Halud-4 (28.7 t/ha) and the lowest from local variety (14.5 t ha^{-1}). BARI Halud-4 gave the highest gross return (Tk. 430500 ha^{-1}), gross margin (Tk. 296750 ha^{-1}) and benefit cost ratio (3.22) followed by BARI holud-5 and local variety, respectively.

On farm adaptability trial of chilli varieties

The experiment was conducted at MLT site, Sadar and Daulatkhan, OFRD, Bhola under AEZ-18 in rabi season of 2019-20. Agronomic performance of BARI developed chilli varieties; BARI Morich-1, BARI Morich-2 and a local variety were evaluated under farmers' field condition to select suitable chilli variety(s) for Bhola region. Plant height, number of fruits plant^{-1} and dry chilli yield ha^{-1} differed significantly due to varietal effect. BARI Morich-2 produced the highest dry fruit yield (1.82 t ha^{-1}). As production cost was same for all tested varieties BARI Morich-2 also gave the highest gross margin (Tk. 131950 ha^{-1}) and the highest BCR (2.52). Local variety produced the lowest dry fruit yield (1.23 t ha^{-1}).

On-farm trial of BARI onion varieties in Kushtia

A field trial on onion bulb was carried out at the FSRD site, Faridpur and Kushtia sadar and MLT site, Mujibnagar, Meherpur during winter season of 2019-20 under farmer's field condition to evaluate the performance of onion varieties against local cultivar. Two BARI released onion varieties viz. BARI Piaz-1 and BARI Piaz-4 were evaluated in the trial against local cultivars at both the locations. At Faridpur, the highest bulb yield was calculated from BARI Piaz-4 (20.68 t ha^{-1}) followed by Lalteer king (19.57 t ha^{-1}) and the lowest from Taherpuri (14.07 t ha^{-1}). The maximum gross margin Tk.544756 ha^{-1} was obtained from Lalteer king. Among the tested varieties, BARI Piaz-4 performed better and gave the highest bulb yield (20.08 and 19.60 t ha^{-1}) at Khustia sadar and Mujibnagar, respectively.

Adaptive trial of BARI coriander variety in plain land of rajshahi

A field experiment was conducted at the MLT site, Shibpur, Puthia, Rajshahi druing 2019-20 to evaluate the performance of BARI Dhonia-2 under farmer's field condition and to popularize among the farmers. BARI Dhania-2 performed better yield (0.98 tha^{-1}) against the local check variety (0.78 tha^{-1}).

Tuber Crops

Adaptive trial with newly released potato varieties in different locations

The trial was conducted at farmers' field of fifteen different locations (Narsingdi, Bhola, Gaibandha, Jashore, Khulan, Kishoreganj, Kustia, Faridpur, Patuakhali, Rangpur, Sherpur, Rajshahi, Tangail, Mymensingh, and Manikganj) under the supervision of On-Farm Research Division during the Rabi season of 2019-20 to evaluate the performance of some BARI developed five selected potato varieties and also to know farmers' judgement about the varieties. BARI released four potato varieties viz. BARI Alu-35, BARI BARI Alu-36, BARI Alu-37, BARI Alu-40, and BARI Alu-41 were used in these trials. Tuber yield among the varieties across the locations was ranged from 21.0 to 44.3 t ha^{-1} where BARI Alu-37 (44.30 t ha-1) was the highest yielder in Sherpur and also produced the 2nd highest tuber yield in Narsingdi (43.20 t ha-1) in Narsingdi. Among the tested potato varieties BARI Alu-41 has produced the average highest tuber yield (34.0 t ha^{-1}) and BARI Alu-40 has produced the second-highest tuber yield (average 33.40 t ha^{-1}). The highest gross margin was recorded from BARI Alu-37 (531120 Tk. ha^{-1}) followed by BARI Alu-36 (496200 Tk. ha^{-1}). According to farmers' judgement BARI Alu-41 and

BARI Alu-40, BARI Alu 37, and BARI Alu-36 could be the best potato varieties in terms of higher tuber yield as well as less insect and disease infestations and higher gross margin.

On-farm trial of BARI released potato varieties in different locations

On-Farm trials with different potato varieties were carried out in the farmers' field under OFRD, Faridpur, MLT site, Modhupur, Tangail, MLT site, Ranigonj, Dinajpur and Kamalbazar, South Surma, Sylhet during the year of 2019-20 to evaluate the performance of the different potato varieties and to popularize them among the farmers. In the trial, potato varieties, BARI Alu-8, BARI Alu-25, BARI Alu-37, BARI Alu-41, BARI Alu-53 were (were used in the Faridpur; BARI Alu-8, BARI Alu-41, BARI Alu-53, BARI Alu-78, and BARI Alu-79 were used in Tangail; BARI Alu-36, BARI Alu-41, BARI Alu-46, BARI Alu-53, BARI Alu-72, BARI Alu-73 were used in Dinajpur and BARI Alu-40, BARI Alu-46, and BARI Alu-53 were used in South Surma, Sylhet. In all trial sites, trials were laid following RCB design with five dispersed replications. The yield performance of most of the varieties appeared to be promising in the tested location. In Faridpur, the highest tuber yield (36.76 t ha^{-1}) was obtained from BARI Alu-41 that was statistically similar to all varieties except BARI Alu-25 that produced the lowest yield (27.62 t ha^{-1}). The tuber yield of BARI Alu-41 was 33% higher than that of BARI Alu-25. In the Tangail site, the highest tuber yield of 37.22 t ha^{-1} was obtained from the variety BARI Alu-78 followed by BARI Alu-41 (36.85 t ha^{-1}) and BARI Alu-79 (36.01 t ha^{-1}). The lowest tuber yield 27.59 t ha^{-1} was obtained from BARI Alu-8. In Dinajpur, the highest tuber yield was obtained from BARI Alu-36 followed by BARI Alu-46. The lowest tuber yield was obtained from BARI Alu-72. In South Surma, Sylhet, the highest tuber yield (32.72 t ha^{-1}) was obtained from BARI Alu-46. On the other hand, BARI Alu-53 gave the lowest tuber yield (23.34 t ha^{-1}). In Dinajpur, the highest gross margin was obtained from BARI Alu-78 (Tk. 175753 ha^{-1}) followed by BARI Alu-41 (Tk. 172053 ha^{-1}) and the lowest gross margin from BARI Alu-8 (Tk. 79453 ha^{-1}); again in Sylhet, the highest gross return and gross margin were recorded from BARI Alu-46 followed by BARI Alu-40. BARI Alu-53 gave the lowest gross return due to lower yield.

Promotion and dissemination of late blight resistant potato varieties in northern districts

The trial was conducted at farmers' field of MLT site of OFRD, Gaibandha, MLT site of Lalmonirhat; MLT site Kurigram, MLT site of Rangpur, MLT site of Rajshahi, and MLT site of Joypurhat during the year of 2019-20 to evaluate the field performance of BARI released three late blight resistant potato varieties (BARI Alu-46, BARI Alu-53 & BARI Alu-77) and to know farmers' judgement about the varieties. Among the tested potato varieties BARI Alu-53 and BARI Alu-46 performed better at all locations and gave 34.54% and 34.40% higher tuber yield than check variety (BARI Alu-25). These are two-variety showed less than 0-5% late blight infection in the foliage. Regarding Common Scab susceptibility, its severity was very low (<3%). The average highest gross margin was recorded from BARI Alu-53 followed by BARI Alu-46. Farmers' judgement about potato varieties varied with locations mostly for yield performance and skin color. According to farmers' judgement the popular BARI Alu-46, BARI Alu-53and BARI Alu-77 were highly resistant to the late blight of potato disease, which cut the fungicide cost greatly and reduced the cost of production without hampering tuber yield. Considering yield, the skin color of the tuber, market demand, and cost-benefit analysis farmers in all locations choose BARI Alu-53.

Promotion and dissemination of climate smart potato varieties in the southern districts

BARI released saline and heat tolerant BARI Alu-72 and heat tolerant BARI Alu-73 were evaluated at the farmers' fields in Satkhira, Khulna, Patuakhali, Borguna, and Coxsbazar to observe their performance in the coastal areas of Bangladesh. The average of soil salinity level ranged from 2.5 to 11.3 dSm^{-1}in Khulna, 2.57 to 7.5 dSm^{-1} in Coxsbazar. 1.02 to 7.04 in Patuakhali. Borguna was non-saline. Among the varieties, the average highest yield was found in BARI Alu-72 (27.19 t ha^{-1}). In all locations, BARI Alu-72 was performed better due to its higher adaptability to heat and saline conditions. Higher average gross return, gross margin, and BCR were accounted from BARI Alu-72 for its higher yield.

Adaptive trial of newly released promising sweet potato varieties in different locations

Field trials with nine BARI released sweet potato varieties (viz. BARI Mistialu-4, BARI Mistialu-8, BARI Mistialu-10, BARI Mistialu-11, BARI Mistialu-12, BARI Mistialu-13, BARI Mistialu-14, BARI Mistialu-15, BARI Mistialu-16) along with one Local variety were carried out at farmer's field of MLT site OFRD, Kishoreganj; MLT site OFRD, Narsingdi; MLT site OFRD, Bandarban; MLT site OFRD, Cumilla; MLT site, OFRD, Jessore; MLT site OFRD, Madaripur; MLT site OFRD, Netrokona; MLT site OFRD, Bogura; MLT site OFRD, Sylhet and MLT site OFRD, Gaibandha during rabi, 2019-20 to evaluate the comparative performance of BARI released high yielding sweet potato varieties. The root yield sweet potato was ranged from 12.35 to 48.90 t ha^{-1}, where BARI Mistialu-12 has produced the highest tuberous root yield (48.90 t ha^{-1}) at Cumilla and the local variety was produced the lowest tuberous root (12.35 t ha^{-1}) in Madaripur. Among the sweet potato varieties, BARI Mistialu-15 has produced the average highest tuberous root yield (34.21 t ha^{-1}) followed by BARI Mistialu-12 (33.79 t ha^{-1}), BARI Mistialu-4 (31.65 t ha^{-1}), and BARI Mistialu-8 (31.08 t ha^{-1}) while local variety was produced the average lowest tuberous root yield (22.83 t ha^{-1}). Again, among the locations, the average highest tuberous root yield (38.13 t ha^{-1}) was recorded at Bandarban and the average lowest tuberous root yield (22.98 t ha^{-1}) was recorded at Jashore. The highest gross return (724,000 Tk ha^{-1}) and gross margin (548,320 Tk ha^{-1}) was estimated from BARI Mistialu-14 at Cumilla and the lowest was obtained from the same variety, BARI Mistialu-14 (gross return 157,920 Tk ha^{-1}and gross margin 93,570 Tk ha^{-1}) at Kishoreganj.

Adaptive trials with newly released mukhikachu varieties at different locations

The experiment was conducted at the MLT site of Karimganj, Kishoreganj MLT site of Chuadanga, and MLT site Cumilla during the Kharif season of 2018-19 to evaluate the performance of Mukhikachu varieties under farmers' field condition and to know the farmers choice for commercial cultivation of these varieties. The local cultivar in Chuadanga produced the highest corm yield (38.20 t ha^{-1}) followed by BARI Mukhikachu-2 (36.70 t ha^{-1}) in Chuadanga while the local variety in Kishoreganj was produced the lowest (16.80 t ha^{-1}). The average highest yield was obtained from BARI Mukhikachu-2 followed by BARI Mukhikachu-1. The highest gross return (764000 Tk.ha^{-1}), gross margin (59900 Tk.ha^{-1}), and BCR (4.63) were obtained from the Local mukhikachu cultivar in Chuadanga.

Adaptive trials with newly released varieties of panikachu at different locations

The experiment was conducted at MLT site Sherpur, Kishoreganj, and Cumilla during the Kharif season of 2018-19 to evaluate the performance of Panikachu varieties under farmers' field and to popularize among the farmers. Six varieties viz. BARI Panikachu-1, 2, 3, 4, 5, 6, and local were compared in this trial. BARI Panikachu-1 (24.90 t ha^{-1}) produced the highest stolon weight followed by local variety (23.7 t ha^{-1}) in Cumilla. The lowest stolon yield was found in Sherpur from BARI Panikachu-6 (5.34 t ha^{-1}). The rhizome yield was ranged from 5.25 to 62.63 t ha^{-1}, where BARI Panikachu-6 (62.63 t ha^{-1}) produced the highest rhizome yield in Sherpur followed by BARI Panikachu-4 (37.00 t ha^{-1}) and BARI Panikachu-5 (35.15 t ha^{-1}) in the same location. The lowest rhizome yield was in Cumilla from BARI local cultivar (5.25 t ha^{-1}). The highest gross return (580340 Tk. ha^{-1}), gross margin (410,190 Tk. ha^{-1}) was obtained from BARI Panikachu-6.

Pulse Crops

Onfarm trial of short duration lentil

The experiment was conducted at MLT site Tularampur, Narailunder AEZ 11during 2019-20 to evaluate the performance of BARI Mosur-9 comparing with BARI Mosur-8 and Local in farmers' field. BARI Mosur-8 showed the highest yield (1.89 t ha^{-1}) followed by Local variety (1.55 t ha^{-1}) and the lowest for BARI Mosur-9 (1.31 t ha^{-1}). Days to maturity were higher for BARI Mosur-8 and Local whereas it was lowest in BARI Mosur-9.

Performance of grass pea varieties relaying with T. Aman rice in Bhola

The experiment was conducted at Dawlatkhan, Bhola under AEZ-18 in *rabi* season 2019-20 to observe the performance of BARI developed Grass pea varieties and to compare it with local variety in relay with T.Aman rice under farmers' field condition.BAI Khesari-2, BAI Khesari-3 and local variety were tested in this study. The experiment was laid out in RCB design with six dispersed replications. BARI Khesari-3 produced the highest*seed yield (*1.36 t ha^{-1}) followed *by* BAI Khesari-2 (1.24 t ha^{-1}). *The lowest seed yield* (0.91 t ha^{-1}) *was obtained from local Grass pea variety.*It was 23.51% higher compared to local variety. Due to higher seed yield BARI Khesari-3 showed higher gross return (Tk.54400 ha^{-1}), gross margin (Tk.30635 ha^{-1}) and also higher BCR (2.29).

Performance of garden pea relay with t. Aman rice in Bhola

The experiment was conducted at Sadar and Daulatkhan, Bhola under AEZ-18 in Rabi season 2019-20. Performance of BARI developed garden pea *variety* was tested under farmers' field condition in relaying with T.Aman rice and Line sowing method after T.Aman harvest to select suitable and profitable planting method for Bhola region. BARI Motorshuti-1 was tested for this study. The experiment was laid out in a RCB design with six dispersed replications. *BARI* Motorshuti-1 produced higher green pod yield (6.25 t ha^{-1}) at Line sowing method than relay methods (5.86 t ha^{-1}). Due to higher green pod yield in Line sowing method showed higher gross return (Tk.250000 ha^{-1}) and gross margin (Tk.191620 ha^{-1}). BCR (5.5) was found higher in relay method due to lower total variable cost.

Adaptive trial with BARI released grass pea varieties in Barishal

A field experiment was conducted at MLT site, Barthi, Gournadi, Barishalunder AEZ 13 during the Rabi season of 2019-20 to evaluate the performance of existing grass pea varieties. Three selected Grass pea varieties viz. BARI Kheshari-1, BARI Kheshari-2, BARI Kheshari-3 and local grass pea were evaluated in the trial. The results showed that all the characters under this study were significantly different among the varieties. The results revealed that, the highest seed yield was produced by BARI Kheshari-3 (1688.8 kg ha^{-1}) which was followed by BARI Kheshari-2(1542.3 kg ha^{-1}) and the lowest grain yield (682 kg ha^{-1}) was obtained in local grass pea.

Regional yield trial of chickpea in hbt

A field trial was conducted in the farmer's field of FSRD site, Basantapur, Godagari, Rajshahiunder AEZ 26during the *rabi* 2019-20 to develop variety through farmer's selection under Barind environments. Three advanced lines of chickpea viz.BCX-13005-8, BCX-13004-4, BCX-13002-2 and two varieties BARI Chola-5 and BARI Chola-10 as a check were tested in the farmer's field. The genotypes were evaluated for yield and yield components like days to flowering, days to maturity, plant height, no. of plants m^{-2}, no. of pods plant^{-1}, 1000 grain wt, grain and straw yield etc. with the close supervision of OFRD, Barind Station, Rajshahi. Among the tested entries, BARI Chola-10 (1.65 t ha^{-1}) gave maximum grain yield and 2nd highest seed yield produced by line BCX-13004-4 (1.59 t ha^{-1}) and BCX-13002-2(1.45 t ha^{-1}), respectively which are statistically significant. BARI Chola- 5 gave minimum yield (1.34 t ha^{-1}). Though varieties BARI Chola-10 was the highest yielder but considering the yield and yield contributing characters like plants m^{-2}, no. of pods plant^{-1}, 1000 grains wt and seed yield BCX-13002-4 is also a suitable one among the tested lines for chickpea production in High Barind Tract.

Adaptive trial of BARI released lentil varieties in Kushtia

The experiment was conducted in Kushtiasadar and MLT sites of Bheramara, Gangni, Mujibnagar, and Chuadanga during *rabi* season 2019-2020 in farmer's field to observe the performance of lentil variety in those areas. Four BARI released lentil varieties such as BARI Masur-6, BARI Masur-7, BARI Masur-8, BARI Masur-9 with local check variety were tested. Among the tested varieties, BARI Masur-8 performed better and gave the highest seed yield and economic return in all locations.

Oilseed Crops

Adaptive trial of advanced lines of rapeseed

An adaptive trial was conducted in the farmer's field of Pabna, Tangail, Netrakona and Cumilla during the *rabi* season of 2019-20 with a view to evaluated the yield performance of some advanced lines of short duration mustard so that these lines could fit in the existing cropping pattern. The trial consisted of different advanced lines in the tested locations. Rapeseed lines *viz*., BC-120114, BC-100614-3 and BC-100614-4 along with BARI Sarisha-14 as check at Pabna; advanced lines viz. BC-120114, BC-100614(4)-10, and BC-100614(3)-1 with BARI Sarisha-14 as check at Tangail; advanced lines namely; BC-100614(3)-1, BC-100614(4)-10, BC-120114 and BARI Sarisha-14 as check at Netrakona and four advanced lines viz. BC-120114, BC-100614(3)-1, BC-100614(4)-10 and BARI Sarisha-14 as check were used at Cumilla in the trial. The experiment was laid out in RCB design with three replications. Among the tested lines/varieties, higher grain yield was obtained from BC-100614-3 (1.91 t ha^{-1}) and the lowest from BC-100614-4 (1.42 tha^{-1}) in the farmer's field of Pabna but higher gross return (Tk. 29740 ha^{-1}) was obtained from BC-100614-3. At Tangail, BC-120114 (1.26 tha^{-1}), BC-100614(3)-1 (1.26 t ha^{-1}), and BARI Sarisha-14 (1.33 tha^{-1}) gave statistically similar yield and the lowest from BC-100614 (4) -(101.11 tha^{-1}). The highest gross margin (Tk.21165 ha^{-1}) was obtained from BARI Sarisha-14 and lowest (Tk. 11115 ha^{-1}) from BC-100614(4)-10. Advanced lines BC-100614(4)-10 gave significantly higher yield (2237 kg ha^{-1}) than other two lines and check variety at Netrakona. BARI Sarisha-14 (1700 kg ha^{-1}) produced the lowest yield which was statistically similar with BC-100614(3)-1 (1750 kg ha^{-1}) and BC-120114 (1800 kg ha^{-1}). The highest gross margin (Tk.63495.00 ha^{-1}) was recorded in BC-100614(4)-10. At Cumilla, the advanced line BC-100614(4)-10 produced the highest seed yield (2.46 t ha^{-1}) compared to other lines (2.37 and 2.30 t ha^{-1}) and check variety BARI Sarisha-14(2.20 t ha^{-1}).

On-farm trial of BARI released short duration mustard varieties

The experiment was conducted at Gournadi, Barishal; Kanaipur, Faridpur; Bhuapur, Tangail and Ranigonj, Dinajpur during the Rabi season of 2019-20 to evaluate the performance of BARI released mustard varieties in the farmers field. BARI mustard varieties *viz*., BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-17 and local mustard variety as check were evaluated in the trial. But at Dinajpur BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-16 were compared with local variety Tori-7. The trial was carried out in RCB design with six dispersed replications. At Barishal, the highest seed yield (1767.8 kg/ha) was produced in BARI Sarisha-17 followed by BARI Sarisha-15 (1568.2.3 kg/ha) and the lowest (850.2 kg/ha) in local cultivar maghi. In the farmers' field of Faridpur, the highest seed yield (1618 $kgha^{-1}$) was obtained from BARI Sarisha–17. The lowest yield was found in BARI Sarisha-15 (1444 $kgha^{-1}$). In Tangail, BARI Sarisha-17 (1.64 t ha^{-1}) gave the highest seed yield followed by BARI Sarisha-14 (1.40 t ha^{-1}) and BARI Sarisha-15 (1.34 t ha^{-1}) gave the lowest yield. At Dinajpur, the highest yield was obtained from BARI Sarisha-16 (1.89 t ha^{-1}) and the lowest in Tori-7 (0.89 t ha^{-1}).

Adaptive trial of mustard genotype in high barind tract

A field trial was conducted in the farmer's field at FSRD site Basantapur, Godagari, Rajshahi during 2019-20 cropping season to know the performance of mustard varieties in High Barind Tract. Three lines and one check variety of mustard viz. BJDH-11, BJDH-12, JUN-536 and BARI Sharisha-16 were tested in the farmer's field. Among the tested varieties BJDH-12 line gave the maximum seed yield (2.03 t ha^{-1}) followed by BJDH-11(1.88 t ha^{-1}) and the line JUN-536 gave the minimum seed yield (1.67 t ha^{-1}).

Adaptive trial of mustard genotype in level barind tract

A field trial was conducted in the farmer's field at MLT site, Joypurhat during 2019-20 cropping season to assess the performance of mustard varieties in Level Barind Tract. Three lines and a check variety of mustard viz. BJDH-11, BJDH-12, JUN-536 and BARI Sharisha-16 were tested in the farmer's field. Among the varieties, BARI Sarisha-16 gave the maximum seed yield (1.95 t ha^{-1}) followed by BJDH-12 (1.90 t ha^{-1}) and BJDH-11 (1.76 t ha^{-1}). The line JUN-536 exhibited the minimum seed yield (1.1.72 t ha^{-1}).

Adaptive trial with mustard genotype in southern belt of Bangladesh

The experiment was conducted in the farmer's field at MLT site, Koyra, Khulna during *rabi* season 2019-20 to evaluate the performance of five mustard genotypes viz. BJDH-12, JUN-536, BD-6950, BD-7104 and BD-10115. The trial was laid out in RCB design with six dispersed replications. Significant variation was observed in seed yield and yield contributing characters among the tested genotypes and JUN-536 produced the highest yield (1.38 t ha^{-1}).

On-farm trial of long duration BARI mustard varieties

The trial was conducted at the FSRD site, Sholakundu, Kanaipur, Faridpur and the MLT site, Shibpur, Puthia, Rajshahi during *rabi* season of 2019-20 to evaluate the performance of long duration mustard varieties in the farmers' field. BARI sarisha-11, BARI Sarisha-16 and BARI sarisha-18 were included in the study. The experiment was designed in RCB with six dispersed replications. The highest seed yield (1796 $kgha^{-1}$) was recorded in BARI Sarisha–18 and the lowest in BARI Sarisha-16 (1750 $kgha^{-1}$) at Faridpur. The highest gross margin (Tk. 35854 ha^{-1}) and BCR (1.74) was observed in BARI Sarisha-18. BARI Sarisha-16 (2.04 t ha^{-1}) gave higher yield in the farmers' field at Rajshahi.

On farm adaptive trial of BARI sesame varieties

An experiment was conducted at Kumarkhali upazila under Kushtia district and the FSRD site, Faridpur during *Kharif* I season of 2020 to evaluate the performance of advanced lines of sesame in the farmers' field and to select suitable varieties for the tested locations. Three BARI released sesame varieties viz. BARI Til-3 and BARI Til-4 with local variety as check at Kushtia and four advanced lines viz. Ses-9768, Ses FR-20, Ses-PR-20 and Ses MR-20 along with a check variety BARI Til-4 at Faridpur were evaluated in the study. In Kushtia, BARI Til-4 (1.51 t ha^{-1}) produced the highest seed yield followed by BARI Til-3 (1.36 t ha^{-1}). BARI Til-4 and BARI Til-3 gave 12 and 1% higher seed yield over the check variety (1.35 t ha^{-1}). Advance lines Ses MR-20 (821 kg ha^{-1}) gave 44% higher seed yield than BARI Til-4.

Performance of linseed variety in charland ecosystem

The experiment was conducted at FSRD site, Atia and MLT site, Bhuapur under Tangail district during Rabi season of 2018-19 and 2019-20 to evaluate the yield performance in farmers' field and to select suitable linseed cultivar Four cultivar viz. Patuakhali local, Noakhali local and Jokiganj local along with BARI released variety Neela as check were tested. The experiment was laid out in RCB design with three replications. The highest seed yield was obtained from Patuakhali local (0.88 and1.16 tha^{-1}) at FSRD site, Atia and MLT Site, Bhuapur, Tangail, respectively followed by Neela (1.03 tha^{-1}). The lowest seed yield was obtained from Jokiganj local (0.58 and 0.92 tha^{-1}) at both the locations, respectively.

Adaptive trial of advanced lines of linseed

The experiment was conducted at Daulatkhan under Bhola district; Titash under Cumilla district and Hazigong under Chandpur district during Rabi season of 2019-20 to evaluate the performance of advanced lines of linseed in the farmers' field. At Bhola, three advanced line viz. Lin-W-17, Lin-1502/3 and a check variety Neela whereas two advanced lines i.e. Lin W-17, Lin-1503/2 and one variety Neela as check was tested at Cumilla. The trial was laid out in RCB design with four replications. The advanced line Lin-W-17 gave higher yield 1.15 and 1.34 kg ha^{-1}, respectively in the farmer's field of Bhola and Cumilla but days to flowering and maturity of this line delayed by 7-10 days than Neela at Cumilla.

On farm trial of BARI sunflower varieties

The experiment was conducted at Patuakhali, Tangail and Faridpur during the *rabi* season of 2018-19 and 2019-20 in the farmers' field to select suitable variety of sunflower and to increase production and farmers income. Three sunflower varieties viz. BARI Surjamukhi-2, BARI Surjamukhi-3 and Hysan-33 at Patuakhali but at Faridpur two varieties viz, BARI Surjamukhi-2 and Hysun 3 were evaluated. The experiment was conducted in RCB design with six dispersed replications in each location. Significant difference was found in grains $head^{-1}$, 1000-grain weight and grain yield. The highest yield was observed from the BARI Surjamukhi-2 (2.45 tha^{-1}) and the lowest was obtained from BARI Surjomukhi-3 (1.98 tha^{-1}). BARI Surjamukhi-2 gave seed yield 1.83 and 1.93 t ha^{-1} at MLT site, Bhuapur and FSRD site, Atia, Tangail, respectively in the two-consecutive year. At Faridpur, seed yield of BARI Surjamukhi-2 and Hysun-33 were 2.20 and 2.52 t ha^{-1}, respectively.

Adaptive trial of soybean varieties

The experiment was conducted in the farmer's field at West Al-Amin, Subarnachar upazila under Noakhali district during *rabi* season of 2019-2020 to select suitable soybean variety for charlands under rainfed condition. The experiment was laid out in RCB design with six dispersed replications. Seven soybean varieties namely BU Soybean-1, BINAsoybean-2, BINAsoybean-3, BINAsoybean-5, BARI Soybean-5, BARI Soybean-6 and a local variety (Shohag) as check were evaluated in the study. Among the tested varieties, the highest seed yield was obtained from BARI Soybean-6 (2.26 t ha^{-1}) which was statistically similar with BU Soybean-1 (2.20 t ha^{-1}) and BINAsoybean-5 (2.19 t ha^{-1}) and the lowest yield (1.74 t ha^{-1}) was obtained from local variety (Shohag).

Adaptive trial of advanced lines/varieties of soybean

The experiment was conducted at Bhola and Chandpur in Rabi season of 2019-2020 to select suitable soybean variety under rainfed condition. At Bhola, four BARI developed soybean lines/varieties viz. Santarose-1, Santarose-2, BARI Soybean-5 and BARI Soybean-6 while BARI Soybean-5, BARI Soybean-6 and Santarose and a local variety Shohag at Chandpur were tested in the farmers' field. The experiment was laid out in RCB design with four dispersed replications. Among the tested varieties, Santarose-1 produced higher seed yield (1.62 tha^{-1}) followed by Santarose-2 (1.56 t ha^{-1}) and the lowest (1.41 tha^{-1}) was in BARI Soybean-6. At Chandpur, BARI Soybean-5 gave the highest seed yield (2376.00 kg ha^{-1}) which was statistically similar to the lines Santarose (2341.00 kg ha^{-1}) and the lowest (1832.00 kg ha^{-1}) in local variety Shohag.

On-farm trial of BARI groundnut varieties

The experiment was conducted at Dikrirchar, Faridpur; FSRD site Dumki, Patuakhali; MLT site, Bhuapur, Tangail and MLT site Barura, Cumilla during Rabi season of 2019-20 to find out the suitable groundnut variety for the charlands and to popularize the varieties among the farmers. At Faridpur, three BARI developed groundnut varieties viz., BARI Chinabadam-8, BARI Chinabadam-9, BARI Chinabadam-10 and a local variety (Dhaka-1); at Patuakhali; four varieties viz. BARI Chinabadam-10, BARI Chinabadam-8, BINA Chinabadam-1 and Dhaka-1; at Tangail, three BARI developed groundnut varieties viz. BARI Chinabadam-8, BARI Chinabadam-9, and BARI Chinabadam-10 and at Cumilla, three BARI developed groundnut varieties viz. BARI Chinabadam-8, BARI Chinabadam-9, BARI Chinabadam-10 and one BINA developed variety viz. Binachinabadam-4 and a local (Dhaka-1) as check were evaluated. At Faridpur, BARI Chinabadam-10 gave the highest nut yield (1.47 t ha^{-1}) followed by BARI Chinabadam-8 (1.39 tha^{-1}) and BARIChinabadam-9 (1.32 tha^{-1}) and Dhaka-1 (1.29 tha^{-1}) produced lower and statistically similar yields. At Patuakhali, BARI Chinabadam-8 performed better (2.33 t ha^{-1}) followed by BINA Chinabadam-1 (2.21 t ha^{-1}) and BARI Chinabadam-10 (1.95 t ha^{-1}) and the lowest (1.89 t ha^{-1}) from farmer's variety Dhaka-1. At Tangail, BARI Chinabadam-8 produced the highest yield (2.04 t ha^{-1}) statistically at par with BARI Chinabadam-9 (1.71 t ha^{-1}) and BARI Chinabadam-10 (1.60 t ha^{-1}) gave the lowest yield. In the farmers field of Cumilla, BARI Chinabadam-10 (3.0 tha^{-1}) performed the best followed by Binachinabadam-4 (2.83 tha^{-1}) and BARI Cinabadam-9 (2.27 tha^{-1}) and BARI Cinabadam-8 (1.97 tha^{-1}) gave the lowest yield.

On-farm trial of BARI released Bt brinjal varieties in bangladesh

The field trial was conducted at 23 districts of Bangladesh such as Bagerhat, Bandarban, Bhola, Bogura, Brahmanbaria, Cox's bazar, Cumilla, Chandpur, Faridpur, Gazipur, Khulna, Kushtia, Kishoreganj, Manikganj, Mymensingh, Narail, Narsingdi,Noakhali, Patuakhali, Rangpur, Satkhira, Sherpur and Tangail during 2019-2020 to observe the performance of transgenic BARI Btbrinjal varieties at the farmers' field. Tested fourBARI Btbrinjal varieties performed better against non Bt counterparts, reduced brinjal shoot and fruit borer

(BSFB) infestationproduced maximum healthy fruit and offered higher gross margin in all locations.These varieties showed maximum 0-2.65% shoot, 0-3.45% fruit infestation by number, 0-3.16% fruit infestation by weight and 18.15-41.85 t/ha yield against 10.0-84.60% shoot, 6.30-69.82.60% fruit by number, 6.82-83.70% fruit infestation by weight and 4.14-31.50 t/ha yield in non-Bt counterparts. Among the 23 districts, field trial under 21 districts totally free from BSFB infestation.

Integrated farming research and development for livelihood improvement in the plain land eco-system

Livelihood encompasses people's capabilities, income, assets and activities required to secure the necessities of life. The sustainable livelihood is an approach to poverty eradication. Integrated farming is now gaining priority to ensure food, nutrition and income security of resource poor farm households with the rapid increasing of population and declining of agricultural land. From these views, the program was undertaken to develop integrated farming technologies, fine tune the technologies generated by NARS institutes, integrate component technologies with efficient use of farm resources and thereby improve family income and livelihoods. The integrated farming programs were started from February 2018 at 5 Farming Systems Research and Development (FSRD) Sites *viz*., Ajoddhapur (Rangpur), Gangarampur (Pabna), Sholakundu (Faridpur), Atia, Delduar (Tangail) & Tarakandi (Sherpur). The activities persistently continued during February 2019-January 2020. A total of forty-five types of activities were done for maximizing the total productivity using the existing resources of sixty farmers, where twelve from each location comprising of four from each of marginal, small and medium farmers group considering homestead vegetables & fruits, field crops, poultry & livestock, fisheries and off-farm component. All components were brought under improved technological intervention and accordingly incomes were increased from these components. The average homestead size was 0.05, 0.14, 0.09, 0.13 and 0.07 ha at FSRD site Rangpur, Pabna, Faridpur, Tangail and Sherpur, respectively. In homestead component, four types of activities were done with year-round vegetables and fruits production, new plantation and fruit tree management. The average vegetables produced per homestead 687 kg after intervention (AI), which was only 167 kg before intervention (BI). The average vegetables consumption during AI was 251g head^{-1}d^{-1}, which was 382% higher than BI. The average fruits produced per homestead 575 kg, which was only 290 kg during BI. The daily nutritional requirements of a family members were supplemented considerably especially carotene and Vit-C due to increased consumption of homestead vegetables and fruits. *F*ruit tree management has created a good impact and a total of 611 fruit trees were brought under pest management and a total of 1664 saplings of different fruits were distributed in different FSRD sites. Women participation in agricultural activities increased to a great extent that showed some positive effect on gender equity within the family. The average crop land size was 0.62, 0.84, 0.64, 0.61 and 0.54 ha in Rangpur, Pabna, Faridpur, Tangail and Sherpur area, respectively. In field crops component, a total of 10 types cropping pattern (CP) improvement and 15 types of on-farm trials were conducted. Two or three crops-based CP could be successfully replaced by three to four crops-based CP. Among them potato included 4 crop-based CP T. Aus-T**.** Aman-Potato/Sweet gourd and T. Aus-T**.** Aman-Potato-Mungbean produced higher REY 40.68 and 32.96 t ha^{-1}, repectively where sole crop Tomato gave maximum gross margin (Tk. 662000 ha^{-1}). Twelve types of activities are going on in the livestock component. After deworming and vaccination, the frequency of major diseases e.g. Anthrax, FMD, PPR, BQ etc. were reduced to below 5% and addition of vitamin ADE increased the lactation period and yield remarkably. Cattle fattening and calf rearing programs are creating interest among the farmer due to remarkable gain of cattle body weight (34-65%). In poultry system, Sonali chicken, Naked-neck chicken, Khaki Campbell duck, Turkey bird and pigeon rearing in homestead created a good impact as a good source of income and child nutrition. Mortality of poultry reduced *(*64-100*%)* after vaccination. *F*arm yard manure (5375 kg homestead^{-1}) and green fodder (52 t ha^{-1}) production were found promising. The average pond size was 0.04-0.06 ha over the locations. *Seasonal c*arp polyculture gave a satisfactory fish yield *(*avg. 176 kg pond^{-1}*)* and gross margin *(*avg. Tk. 12513 pond^{-1}*)* at farmers' level. From different types of off-farm activities (e.g. weaving Katha, sweing cloths, making handicrafts & Kumra Bora, grocery shop, pulling van/rickshaw etc.), farmers also earned some extra money *(*avg. *g*ross margin Tk. 5882 household^{-1}*)*. Field days organized during rainy season on homestead gardening and also on T. Aus rice production created a positive impact in the locality.

Climate resilient farming systems research and development for the coastal ecosystem

For developing sustainable cropping patters on-farm verification trials on cash crop were conducted in both the locations during *Rabi* season of 2019-20 cropping year. Besides on-farm trials, Aus rice crop was established among farmers (in each location) with the modern variety such as BRRI dhan48, BRRI dhan82, BRRI dhan83, BRRI dhan85 and Binadhan-19. With the aim of improving soil health, eight farmers field were selected for green manuring crops cultivation and eventually, incorporated just before flowering in Noakhali. High value crops like summer tomato cultivation was introduced among four (04) farmers with modern variety of BARI Hybrid Summer Tomato-8, BARI Hybrid Summer Tomato-10 and BARI Hybrid Summer Tomato-11. On the other hand, Sorjan method was implemented in Patuakhali. For improvement of cropping pattern, land type based T. Aman rice varieties (BRRI dhan23, BRRI dhan52 and BRRI dhan87) were cultivated in all farmer in both the locations. In both the location, two alternate cropping pattern were introduced such as Groundnut (Dhaka-1)-D./T. Aus ((BRRI dhan85) - T. Aman (BRRI dhan87), Proso millet (BARI Cheena-1) - Green manure - T. Aman (BR23), Potato (BARI Alu-72) - T. Aus (BARI Mung-6) -T. Aman (BRRI dhan49) and Sunflower (BARI Surjomukhi-2) - T. Aus (BRRI dhan48) -T. Aman (BRRI dhan52). Moveable seed was introduced for winter vegetables seedling production in Noakhali. Several farmers of Noakhali cultivated Cabbage, cauliflower, broccoli and tomato in the small-scaled. Surprising all farmers willing to cultivate onion eventually all farmers started to cultivate with a land vary 1 to 1.5 dec. For preservation of high yielding varieties seed, plastic drum (180 kg) along with plastic bag (40 kg) were also distributed in the farmers of Noakhali. A total of 168 saplings were distributed to enrich agroforestry system with 06 types of fruit trees (Noakhali). Year round vegetable production through modiefied "Atkapalia" Model and "Lebukhali" Model are being practiced among the co-operative farmers. Vaccination of livestock and poultry was done as when necessary for sustaining the production system. Moreover, chick, duck, turkey, titir and pigeon were distributed with the aim of more meat production. Despite poultry, phak chong-1 fodder cuttings was also planted in three farmers' field to increase fodder production. To increase farmer's income through aquaculture system, fingerlings of monosex tilapia (02 famers), shorputi (01 famer), different kinds of carp (07 famers), shing (01 famer) and Koral (01 famer) fingerlings were distributed among the farmers depending on the pond size and other existing frameworks of the famers in Noakhali whereas mixed crarp polyculture (03 famers) and single culture of monosex tilapia (04 famers) were cultured in Patuakhali. Furthermore, co-operative farmers were encourage to manage the pati pata plant occupied in their pond banks or other partially shady places and weaving attractive design Shital Pati in Noakhali site. Continuous follow up evaluation were made by the concerned scientists.

Floating agriculture based integrated farming research and development for livelihood improvement of farmer

Integrated farming is termed as integrated resource management. Sustainable local natural resource management in the submerged areas through floating agriculture based integrated farming practices may be a good option for improving livelihood and coping up with the climate change situation.From these views, the program was undertaken to generate floating agriculture based modern and appropriate technologies, to develop the management technologies of different cropsunder floating agriculture system, and thereby to increase the yield and economic return of floating agriculture through vegetables, spices, forage, livestock, fisheries and homestead gardening under integrated approach.The research and development activities under floating agriculture based integrated farming were carried out in 5 locations of low-lying areas of southern

Bangladesh (Tungipara, Gopalganj sadar and Kotaliparaupazilla under Gopalganj district; Nazirpurupazilla under Pirojpur district; and Mollahatupazilla under Bagerhat district) during the year of 2017-18 to 2018-19.A total of twenty-nine types of activities were done for maximizing the total productivity using the existing resources of 120 farmers (60 farmers under OFRD, BARI and 60 farmers under Palli-Bangla Unnayan ShahojogitaSangstha-PBUSS). Among them12 farmers from each location comprising of 6 from each of marginal and small farmers group considering floating agriculture and mainland crops, homestead vegetables & fruits, poultry & livestock, fisheries and off-farm component under OFRD, BARI. All components were brought under improved technological intervention and accordingly incomes were increased from these components. The average waterlogged land size per farmerwas 27, 25, 24, 15 and 15 decimals in Nazirpur, Gopalganj Sadar, Tungipara, Kotalipara, and Mollahat, respectively. In waterlogged land, floating agriculture based a total of 15 types research and development activities were conducted focusing screening of vegetables, spices, and forage; standardization of bed size; nutrient management; agronomic management; pest and disease control etc.In rabi season of 2018-19, among the seven vegetable crops (bottle gourd, bitter gourd, sweet gourd, okra, Knolkhol, yard long bean and spinach) bottle gourd was found more profitable (gross margin, GM= Tk. 1925/bed, BCR= 2.01). In kharifseason of 2018-19, among the six vegetable crops (bottle gourd, bitter gourd, sweet gourd, sponge gourd and cucumber) bottle gourd also found more profitable (GM= Tk. 2000/bed, BCR= 2.05). The poorest performance was found in bitter gourd. In Mollahat, it was revealed that additional chemical fertilizar application in floating bed can increase okra production by 44%. In case of spices crops, BARI Holud-5 performed better in both Kotalipara (200 kg/bed) and Tungipara(193kg/bed), where BARI Halud-3 performed better in Mollahat(280kg/bed). Napier and Pakchon was produced in floating bed at Kulia and Ghatbila ofMollahat and found that Napier (627 kg/bed) produced more green fodder than Pakchon(528 kg/bed) from 11 times cutting. Under the experiment of integrated pest and disease management by insecticide, fungicide and trap in floating bed, bottle gourd performed better (248 kg/bed).Among the rat control methods in okra producing floating bed, simultaneous use of both rat trap and poison bait was found promising than sole method in Tungipara and Nazirpur. In the bed size standardization experiment, it was found that 40m x 1.5m x 0.30m bed size is more profitable for crop production under floating system, where more depth (0.30m) was revealed as suitable than 0.25m and 0.20m for successful crop production.The traditional cropping pattern Fallow-Floating bed-Fallow was replaced by Boro rice-Floating bed-Fallow, where the yield of boro rice was 9.85, 10.67, 10.23 and 9.36 t/ha at Kondorpogati, Kotalipara, Tungipara and Nazirpur, respectively. Bitter gourd grown with trellis produced more fruit yield (11.25 kg/bed) than grown without trellis (8.75 kg/bed) under floating system in Mollahat area.Under agronomic management trial considering transplanting and sowing methods of crop production, in Mollahat, yield of bottle gourd and sweet gourd was increased by 18 and 17%, respectively under transplanting method; in Tungipara and Nazirpur, the yield of cucumber also increased by 6 and 3%, respectively in transplanting method where the yield of okra was increased by 21 and 4%, respectivelyin sowing method. In another experiment at Mollahat, bottle gourd produced more fruit yield in both rabi (241 kg/bed) and kharif(218 kg/bed) season under transplanting method than sowing method. In intercropping experiment using both floating bed and trellis, bottle gourd + red amaranth was found more profitable (Tk 2917/bed) than other cucurbit and red amaranth based intercropping system. Water lily produced naturally in the open water was found a source of extra income (Tk. 200/dec) for the farmers. The average mainland (dry land) size per farmer was 184.33, 212.15, 220.25, 215.31, and 149.94 decimals in Nazirpur, Gopalganj Sadar, Tungipara, Kotalipara, and Mollahat, respectively. In the mainland, 2 types of research and development activities were conducted using the residue (compost) of floating bed. Among the winter vegetables viz. red amaranth, broccoli, chili, spinach, cauliflower, knolkhol and cabbage cultivated in mainland using residue of floating bed at Tungipara, Gopalgonjsadar, Kotaliparaand Nagirpur, broccoli performed better in respect of profitability (GM= 247532 Tk./ha). Tilapia fish culture in cage (size: 20ft x 10ft x 6ft) besides of floating bed in waterlogged area was found promising and 50, 45, 48, 40 and 45 kg fish/cage were produced in Tungipara, Kotalipara, Gopalganj sadar, Nazirpur and Mollahat, respectively. Besides of cage fish culture, open water also a good source of natural fish. Five types of activities are going on in the livestock component. In case of floating system, duck was reared by the farmers and for this regard five ducklings were supplied to each farmer at all locations and after rearing five months the monthly income was calculated 110 Tk./duck.In case of homestead area, after deworming and vaccination of cattle, the frequency of major diseases e.g. Anthrax, FMD, PPR, BQ etc. were reduced to below 10%. In poultry system, Sonali chickenand pigeon rearing in homestead created a good impact as a good source of income and child nutrition. Mortality of poultry reduced (45-86%) after vaccination. Average compost produced from water hyacinth based floating bed ranged 20.10-36.18 t/farmer under floating system and farm-yard manure produced (1850 kg/homestead/yr) in compost pit in homestead area were found promising. The average homestead size was 13, 11, 10, 12 and 12decimals in Nazirpur, Gopalganj Sadar, Tungipara, Kotalipara, and Mollahat, respectively. In homestead component, four types of activities were done with year-round vegetables and fruits production, new plantation, and fruit tree management. The average vegetables produced per homestead 350 kg after intervention (AI), which was only 143 kg before intervention (BI). The average vegetables consumption during AI was 94g/head/day, which was 139% higher than BI. Fruit tree management has created a good impact and a total of 227 fruit trees were brought under pest management and a total of 360 saplings of different fruits were distributed in different locations. Women participation in agricultural activities increased to a great extent that showed some positive effect on gender equity within the family.From different types of off-farm activities (e.g. Pati weaving with Hoglapata, Diar making with bamboo, Kantha sewing etc.), farmers also earned some extra money (avg. gross margin Tk. 7100/household). On an average, the gross margin of a household from different components was increased 68.22%. Integration among the farm components especially floating agriculture-based integration activities are going on. However, the possibility to develop floating agriculture based integrated farming technology would undoubtedly open up opportunities to raise farm income, livelihood and food security in poor people who can benefit of locally available materials and by-products to run sustainable farming.

Screening and selection of different vegetables crops/varieties for floating agriculture system

In *rabi* season of 2018-19, seven vegetable crops viz. bottle gourd, bitter gourd, sweet gourd, okra, knolkhol, yard long bean and spinach were taken to observe their suitability and profitability on water hyacinth made floating agriculture at Ghatbila, Mollahat, Bagerhat. Among the vegetables bottle gourd performed better in respect of yield and profitability. The highest gross margin (Tk. 1925/bed) and BCR (2.01) was recorded from bottle gourd while spinach gave the lowest gross margin (Tk.-1500). In *kharif* season of 2018-19, six vegetable crops viz. bottle gourd, bitter gourd, sweet gourd, sponge gourd and cucumber were cultivated at the same bed and same area to observe their suitability and profitability. Among the vegetables bottle gourd showed better results in respect of yield and profitability. The highest gross margin (Tk. 2000/bed) and BCR (2.05) was recorded from bottle gourd while bitter gourd gave the lowest gross margin (Tk.-825).

Integrated nutrient management for okra production under floating agriculture

The experiment was carried out on water hyacinth based floating bed at Ghatbila, Mollahat, Bagerhat during *rabi* 2018-19. The aim of the study was to observe the response of vegetables to macro- and micronutrient. Okra (variety-Chyanika) was taken as test vegetable crop. Four fertilizer doses were taken as treatment viz. T_1= N-P-K-S-Zn-B : 75-21-15-5-1-0.5 kg/ha, T_2= 75% of T_1, T_3= 50% of T_1 and T_4= Farmers' practice. The highest yield (52 kg/bed) and gross return (1820Tk/bed) were recorded from the bed where N-P-K-S-Zn-B were applied @ 75-21-15-5-1-0.5 kg/ha while the lowest yield (36 kg/ha) and gross return (1260 Tk/bed) were obtained from farmers' practice where no fertilizer was applied. Gross margin was negative in most cases due to its higher cultivation cost.

Up-scaling of improved production technologies of vegetables by using water hyacinth floating bed

Vegetables are very important for human health and it is a good source of many nutrients, including potassium, fiber, folate (folic acid) and vitamins. For this each person is required to take 250g vegetables per day to get vitamins and minerals. Vegetables are mainly grown on high and medium high lands. But farmers living in the low-lying areas traditionally grow selected vegetables on water hyacinth made floating bed during monsoon season. Under floating bed agriculture system, the farmers cultivate only a few numbers of vegetable crops. But the floating bed crops should be diversified to make profitable of the traditional floating agriculture practices. In this respect, adaptation of vegetables can be introduced in floating agriculture system. There for eindianspianch, sweet gourd, bottle gourd, yard long bean, cucumber, okra and bitter gourds were taken for testing the suitability on floating bed. Considering the fact, the experiment was undertaken for making diversification and select the suitable vegetable(s) on floating agriculture.

Performance of different turmeric varieties on floating agriculture system

The experiment was carried out on water hyacinth based floating bed at Mollahat, Bagerhat; Kotalipara and Tungiara, Gopalganj during the year of 2018-19. In case of Kotalipara and Tungipara, BARI Holud-5 performed better than others and the yield were 200 and 193 kg/bed, respectively where lowest yield obtained from BARI Holud-4 and the yield were 110 and 118 kg/bed, respectively. Higher Benefit Cost Ratio (2.60) was found in BARI Holud-5 and the lowest (1.43) was found in BARI Holud-4. In case of Mollahat, Bagerhat, the highest yield 27.6 kg/bed and gross return 1380 taka /bed was found from BARI Halud-3 whereas the lowest yield/bed (21.60Kg) and gross return(1080) was found from BARI Halud-5.

Performance of BARI halud-5 on water hyacinth based floating bed at different locations of bagerhat, gopalganj and pirojpur district

Generally farmers of low-lying areas of Bagerhat, Gopalganj and Pirojpur district grow some spices like turmeric on water hyacinth made floating bed but they used local turmeric variety. In the meantime Bangladesh Agricultural Research Institute (BARI) has developed a good number of high yielding varieties of turmeric and under this project some adaptive trial was conducted at different locations with BARI Halud-3, BARI Halud-4 and BARI Halud-5. Among the tested varieties BARI Halud -5 performed better than others. For this reason a production program was undertaken in the title of ‘‘Production of BARI Halud-5 on floating bed at different locations of Bagerhat, Gopalganj and Pirojpur district’’ owing to disseminate the turmeric cultivation with BARI Holud-5.

Selection of suitable forage variety for floating agriculture system

An experiment was carried out on forage crop production on water hyacinth based floating bed at Kulia and Ghatbila, Mollahat, Bagerhat during 2018-19. The aim of the study was to find out the suitability of forage crops in low-lying area. Napier and pakchon grass were taken as forage crop in the study. The green fodder was obtained 627 kg from Napiar grass and 528 kg from Pakchan grass bycutting 11 times from each bed. The highest gross return (2508 Tk/bed) was found from the bed where Napirer grass was cultivated.

Integrated pest/disease management (insect-pest, diseases, rodents) of sweet gourd, bottle gourd and okra

The experiment was carried out at Ghatbila, Mollahat, Bagerhat during the year of 2018. The objective of the experiment was to control or manage the diseases and insect pest by integrated approach. Three vegetable crops *viz*., bottle gourd, sweet gourd and okra were taken as test crops. Disease like foot rot and root rot were controlled by treating both seed and bed with Bavistin (Carbendazim), and leaf spot was controlled by spraying Dithane M-45 (Mancozeb). In case of insect pest like fruit fly was controlled by spraying chloropyrifos and imidachlorpid. Caterpillar found on floating bed was controlled by applying morter. Maximum number of rodents were caught by steel trap. Considering yield and profitability, bottle gourd produced the highest yield (247.5 kg/bed) with highest gross margin (213) and BCR (1.06) was also calculated from the same crop.

Effect of protection measures against rat infestation on yield of okra

An experiment was carried out on water hyacinth based floating bed at Tungipara, Gopalganj and Nazirpur, Pirojpur district during the year of 2018. The aim of the experiment was to monitor the effectiveness of protection measures against rat infestation and subsequent effect on yield of okra. The highest yield was recorded as 76 and 68 kg at Tungipara and Nazirpur, respectively under farmer's practice (rat trap+ poison bait) while the lowest yield was 58 and 53 kg, respectively in T_2 (rat trap)

Standardization the configuration (shape, size etc.) Of the floating beds

The experiment was carried out on water hyacinth based floating bed at Tungipara in Gopalganj and at Nazirpur in Pirojpur district during the year of 2018. The aim of the study was to observe the response of crop yield to size, shape and depth of floating bed. Okra (Choyonika) was taken as vegetable crop. The highest crop yield was recorded from T_3(40m x 1.5m x 0.30m) where the BCR were 2.08 and 1.50 at Tungipara and Nazirpur, respectively and the lowest yield obtained from T_4(10m x 1.22m x 0.20m) i.e. farmer practice where the BCR were 1.01 and 0.59 at Tungipara and Nazirpur, respectively.

Development of alternate cropping pattern through boro-floating bed-fallow against fallow-floating bed-fallow

An experiment was carried out to develop new cropping pattern at Kondorpogati, Kotalipara and Tungipara in Gopalganj and at Nazirpur in Pirojpur district during the year of 2018-19. The aim of the study was to find out the suitable cropping pattern over the existing one. The traditional cropping pattern of that two places was fallow-Floating bed-fallow where the introduced cropping pattern was boro-Floating bed-fallow. The yield of boro rice at Kondorpogati, Kotalipara and Tungipara in Gopalganj and at Nazirpur in Pirojpur was 9.85, 10.67, 10.23 and 9.36 ton/ha respectively. In floating bed, yield of red amaranth and okra was 215 and 30 kg/bed, 203 and 38 kg/bed, 232 and 33 kg/bed, 210 and 41 kg/bed at Kondorpogati, Kotalipara, Tungipara and Nazirpur, respectively.

Effect of different management practices through trellis on cucurbits

The experiment was conducted at Mollahat, Bagerhat during 2018. The aim of the study was to evaluate the growth and yield performance of the crops on trellis.For this regard, two management practices viz. trellis and non-trellis (farmer practice) were taken under consideration. Bitter gourd was taken as test crop. Between two management practices maximum yield was obtained from trellis and it was 11.25 kg/bed and minimum yield 8.75 kg/bed was received from non-trellis practice.

Improvement of agronomic management for vegetable crops through sowing and transplanting method

An experiment was carried out on water hyacinth based floating bed at Mollahat, Bagerhat; Tungipara, Gopalganj and Nazirpur, Pirojpur during the year of 2018. The aim of the experiment was to evaluate the performance of sowing and transplanting method in vegetable crops on floating agriculture. The highest yield of bottle gourd and sweet gourd were obtained from transplanting method and it was 234 and 35 kg/bedwhile 198 and 30 kg/bedyield of those two crops were received from sowing method in Mollahat, Bagerhat.In case of Gopalganj and Pirojpur, cucumber and okra were cultivated on floating bed. The yield of cucumber recorded higher in transplanting method than sowing and it was 75 and 84 kg at Tungipara and Nazirpur, respectively while the yield of aforesaid cropwas 71 and 82 kg in sowing method. But yield of okra were 57 and 54 kg recorded from sowing method and yield of this two crops were 47 and 52 kg in transplanting method.

Development of suitable planting method for bottle gourd production on floating bed cum trellis in different season

An experiment was carried out on water hyacinth based floating bed in Ghatbila, Mollahat, Bagerhat during rabi and kharif season of 2018-19. The aim of the experiment was to evaluate the performance of sowing and transplanting method in bottle gourd productionin floating agriculture. Bottle gourd was cultivated under this experiment. The highest yield 240.8 and 218 kg/bed were recorded from transplanting method in rabi and kharif season, respectively while the lowest yield 188.74 and 172.50 kg/bed were recorded from sowing method.

Performance of trellis vegetables with intercropping of leafy vegetables on floating bed

Four intercropping system viz. bottle gourd + red amaranth, sweet gourd + red amaranth, Cucumber + red amaranth and bitter gourd + spinach were taken to test the suitability for intercrop at Ghatbila, Mollahat, Bagerhat during rabi 2018-19. Among the four intercropping system, bottle gourd + red amaranth was found suitable in respects of profitability. The highest gross margin (Tk 2917/bed) and BCR (2.53) were calculated from bottle gourd+red amaranth intercropping while the lowest gross margin (Tk. 1040/bed) and BCR (1.54) were recorded from cucumber+red amaranth intercropping.

Performance of naturally grown water lily in open water body

Open water and the water body besides of floating bed is a no-cost source of vegetables production. At this place water lily produced naturally and farmer's harvest it's stem and sold in the market with a satisfactory price. In the market, there is a heavy demand of the water lily stem. It was found that, from a decimal of water body, farmers earn around 200 Taka.

Table 15a. Average water lily stem yield and profitability as vegetable crops naturally grown in open water or water besides of floating bed

Crop	Yield (pcs/dec)	Gross return (Tk./dec)	Total variable cost (Tk./dec)	Gross margin (Tk./dec)
Water lily stem	200	200	No-cost	200

2) Crops in mainland: Different types of research and development activities on vegetables and cereal production in the mainland of a farmer using compost produced from floating bed were conducted to increase productivity.

a) On-farm trial with vegetables using compost of floating bed: Compost produced from water hyacinth made floating bed after finishing crop production on the bed, is an excellent source of organic manure. Research activities were done to see the performance of vegetables production using this compost.

Performance of different vegetables with residue of floating bed in mainland

Winter vegetables viz. red amaranth, broccoli, chili, spinach, cauliflower, knolkhol and cabbage were cultivated in mainland using residue of floating bed at Tungipara, Gopalgonjsadar, and Kotalipara of Gopalgong district and Nagirpur of Pirojpur district. Among the vegetable's broccoli gave best performance in respect ofprofitability.

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Study of the disease reaction of guava native germplasm against *Nalanthamala psidii* new wilt disease pathogen

Wilt disease is a serious threat for guava cultivation which inflicted severe losses in production. In 2019, *Nalanthamala psidii* was identified as a new causal organism for wilt disease of guava from Bangladesh. An experiment was carried out during January to June, 2020 in pot house, Plant Pathology Division, BARI to evaluate the collected guava lines in artificially inoculated condition against wilt disease causing new pathogen *N. psidii*. Guava lines were collected from home garden and orchard as well as local market of Gazipur. In this experiment, NPB-001 isolates of *N. psidii* was used as pathogen, was collected from stock culture of Plant Pathology Division, BARI. Three mycelial plugs of 5 mm diameter were inserted into a 2 cm^2 bark flap on the trunks, 20 mm above the soil line, of three-month-old seedlings of guava lines grown in pots. Plants were evaluated using a scale of 1–5 where 1 = four or less leaves turned purple, 2 = five or more leaves turned purple, 3 = quarter of plant wilted (>8 leaves turned purple, 4 = half of plant wilted and 5 = dead plants. The disease index was calculated as (sum of all numerical ratings/total number of plants) × (100/maximum disease category). Disease reaction was observed after inoculation of mycelial block in trunk of stem. Two line such as LPG1 and LMG1 showed the lowest disease incidence 14.66 and 17.33% after six month of inoculation, respectively. The highest disease index was observed 40% in TMG1 line.

Characterization and evaluation of microbial prevalence in vegetables with newly developed washing machine of BARI

Fresh vegetables contain different chemical and microbial contamination which are responsible for several disease outbreaks of human being. Mechanization may help to reduce microbial load from fresh vegetables. This experiment was conducted during the year 2019-20 in Plant Pathology Laboratory, BARI, Gazipur. In this experiment, effectiveness of vegetable washing machine of BARI was evaluated for increasing physical and morphological characters and removing *E. coli* and *Salmonella* contamination from vegetable. Two lots of carrot were picked up from machine one after 3 minutes and another after 5 minutes of washing and kept 2 hours under room condition for air drying. For testing animal pathogens prevalence, 3 (30ml) cork tube was filled with carrots washed water from tray at 3 minutes and 5 minutes. *E. coli* and *Salmonella colonies* were identified and counted based on colony color on XLD media after 48 hours of incubation at 36$\pm$ 0.5°C.Washing (5 minutes) by newly developed vegetable washing machine of BARI improved the market quality, decreased the fungal growth, and soft rot, and removed 22.20-43.50% more surface bacteria of carrots than traditional hand washed practice.

Evaluation of microbial products for controlling *fusarium* and bacterial wilt of brinjal and Bt brinjal

Fusarium and bacterial wilt disease are caused by soil-borne pathogens and are very difficult to control by any chemical means. An experiment was carried out during 2019-20 to mitigate wilt disease of brinjal by using microbial products. BARI Bt Brinjal-3 was used for evaluation of four microbial products, namely Decoprima (*Trichoderma* sp. + *Geobacillus* + *Steptomyces*), Monaxe (*Pseudomonas* sp.), Biofungicide (BAU), Tricho-compost (BARI) and two biologiacal agents *T. erinaceum* and *Bacillus*sp. Soil was treated before 7 days of seedling transplantation and 30 days after seedling transplantation. The experiment was carried out following Randomized Complete Block design with three replications. The unit plot size was 3.2m x 2.1m. Significant difference was obtained among the microbial products for disease incidence and yield. Significantly the lowest disease incidence (11.11%) was found in the Decoprima applying plot followed by BARI Tricho-compost (13.89%).

First report on *Fusarium oxysporum* F. sp. niveum causing watermelon fusarium wilt in Bangladesh

Watermelon plants wilted were observed 30-70% in commercial fields of Subornachar (22° 662586′ N, 91° 094281′ E), Noakhali, Bangladesh. This experiment was conducted during 2019-20 to identify the pathogen in species level in the laboratory of Plant Pathology Division, BARI. The infected stems and roots (2-3 cm pieces) were surface-sterilized with 1% sodium hypochlorite (NaOCl) for 5 min, rinsed 3 times with sterile distilled water, and placed on half strength potato dextrose agar (PDA). The single-spored isolates produced flat, round, light purple color mycelial growth on the surface and reverse of PDA plates. Hyphae were smooth, hyaline, branched and septate. Fungal inoculum of two isolates, NSWF001 and NSWF004 were prepared with a mixture of sterilized broken maize, wheat bran and grass pea pod seed coat (1:10:5 w/w) for soil inoculation. To confirm their pathogenicity, 15-day-old seedlings (10 seedlings/isolate, repeated three times) of watermelon cv. Sugar Emperor were transplanted into 9-cm-diameter pots filled with soil (treated with 10g inoculum/kg of soil). After 2 weeks, the transplanted seedlings in the inoculated soil showed stunted growth and wilt symptoms similar to those observed in the farmer’s fields. The control seedlings remained healthy. The fungus was successfully re-isolated from stems and roots of infected seedlings on half-strength PDA with the same morphological characters as before, which fulfilled the Koch’s postulation. The internal transcribed spacer of the two isolate were amplified by using primers ITS-1/ITS-4 (White et al. 1990). The ITS sequences of the two isolate NSWF001 (481bp) and NSWF004 (479bp) (Gen Bank accession nos. MN148629 and MN148630) showed 100% similarity with e-value of zero to the reference sequences of *F. oxysporum* (MN633363) and *F. oxysporum f. sp. niveum* (KX275296). Based on the aligned sequences of ITS, molecular phylogenetic analysis by the maximum likelihood method, the isolates NSWF001 and NSWF004 were identified as *F. oxysporum f. sp. niveum*. To the best of our knowledge, this is the first report of watermelon Fusarium wilt caused F. *oxysporum f. sp. niveum* in Bangladesh.

Sensitivity of gummy stem blight causing pathogen *Didymella bryoniae* of watermelon to azoxystrobin + difenconazole

The experiment was conducted during January to June, 2020 in the laboratory of plant pathology division, BARI to evaluate the sensitivity of *Didymella bryoniae* of watermelon to Azoxystrobin + Difenconazole. Azoxystrobin 20%+ Difenconazole 12.5% (supplied by Padma agro sprayers co.) were dissolved in distilled autoclaved water to make stock solutions of 0.04 and 2.0 mg/liter. Aliquots of the stock solutions were added to autoclaved Potato dextrose agar medium cooled to 54°C to yield the final concentrations of 0.001, 0.01, 0.1, 1.0, and 10.0 mg/liter and dispensed into 90-mm petri dishes. Agar plugs (4 mm in diameter) were cut from the edges of source cultures and placed onto fungicide-amended media that were incubated at 23 to 25°C with a 16-h photoperiod. To calculate effective concentration (EC) values that reduced relative colony diameter by 50% (EC50), logit-transformed relative colony diameter was regressed against the base-10 logarithm of the concentrations of fungicide using SPSS 16. All 4 isolates of *D. bryoniae* included in this study were sensitive to Azoxystrobin 20% + Difenconazole 12.5%. The highest mycelium inhibition was 76.18 to 100% at 10mg/l concentration. Three isolates showed similar mean EC50 value 0.01. S005 isolate showed resistant against *D. bryoniae*.

Efficacy of different new fungicides in controlling purple blotch disease of onion

The experiment was carried out in the research field of Plant Pathology Division, BARI, Joydebpur, Gazipur in 2019-20 cropping season to find out the efficacy of some new fungicides in controlling purple blotch disease of onion. Nine (9) new chemical fungicides viz. T_1= Uposom 78 WP, T_2= Technovit 50 WP, T_3= Limizeb 80 WP, T_4= Raben 60 WG, T_5= Azox 50 WG, T_6= Hyprozim 50WP, T_7= Folicur 250 EC, T_8= Victor Plus 60 WDG, T_9= Acibin 28 SC, were used for the experiment with T_{10}=control.

Purple blotch caused by *Alternaria porri* is a very common and destructive disease of onion which adversely affects on bulb as well seed production. The experiment was conducted following Randomized Complete Block Design with three replications. The unit plot size was 2.0 m × 2.0 m. The variety used for the both the experiment of BARI Piaz-4. All the fungicides performed better over the control (unspray) to manage the disease. PDI ranged from 9.50 – 45.00%. The lowest PDI (9.50%) was recorded in Uposom 78 WP treated plot followed by Acibin 28 SC (11.00%) and the highest (45.00%) in control treatment. The highest yield (23.10 t/ha) was recorded in Uposom 78 WP and the lowest (16.22 t/ha) was in control. Among the fungicides Uposom 78 WP, Acibin 28 SC, Hyprozim 50WP, and Raben 60 WG showed the better performance in reduction of disease severity over control.

Evaluation of different fungicides against purple blotch disease of onion

Two experiments were conducted in the research field of Plant Pathology Division, BARI, Joydebpur, Gazipur in 2019-20 cropping season to evaluate the efficacy of some new fungicides as well as some fungicides for second year trail in controlling purple blotch disease of onion. Eight (8) new chemical fungicides as well as nine (9) fungicides for second year trail were tested for the two experiments. Both the experiment was conducted following Randomized Complete Block Design with three replications. The unit plot size was 2 m x 1.2 m for both the experiments respectively. The variety used for both the experiment of BARI Piaz-1. All the fungicides performed better over the control (unspray) to manage the disease. PDI ranged from 9.50 to 45.00%. Considering the disease severity, all the fungicides were found effective against purple blotch disease as compared to unsprayed control. The disease severity ranged from 8.33% to 40.00%. Among the fungicides in experiment no. 01, T_1=Trinazole 75 WDG (8.33%), T_9=Mc Col 70 WP (9.66%) and T_6=Expert 75 WDG (11.00%) were found better in managing purple blotch disease over control treatment (40.00%). The highest yield (22.80 t/ha) was observed in Trinazole treated plot followed by Mc Col (22.33 t/ha) and Expert (21.22 t/ha), respectively. The control treatment showed highest disease severity (40.00%) and the lowest yield (13.99 t/ha) parameters. In experiment no. 02, T_5= Target 75 WDG (10.33%) and T_4=Cycozeb Plus 72 WP (11.66%) and T_3=Sean 75 WDG (12.00%) performed highest disease reduction and observed highest yield (23.10 t/ha) and (22.88t/ha) and (21.66t/ha) respectively over control treatment which represent highest disease severity (50.00%) and the lowest yield (14.18 t/ha). The experiment no. 01 should be continued for second times trail.

Demonstration on integrated management of panama and nemic disease of banana

The demonstration was conducted to assess the performance of developed technology of Plant Pathology Division on panama and nemic disease of banana and farmers practice during September 2019 to April 2020 at Mohespur, Jhenaidah districts under the supervision of Plant Pathology Division, BARI, Gazipur. Two treatments were used for the program; one was developed technology that is 1) T_1=Planting of healthy sucker +Application of Tricho-compost 2kg/plant +Sucker treatment with Autostin 2gm/L of water +Application of Furadan 5G 50gm/plant +Soil drenching with Autostin 3-4 times just after disease initiation and 2) T_2= Farmers' practice. Panama susceptible variety named Shabri kola was planted for the integrated management of panama and nemic disease of banana. Both the treatment has been done with 120 banana plant as replication. The experiment was conducted following Randomized Complete Block Design. Tricho-compost was applied one week before planting into the soil. Sucker treatment with Autostin 2gm/L of water had been done just before the planting. Application of Furadan 5G 50gm/plant were done during planting of banana plant. Between the treatment T_1 (4.16%) perform better in panama and Nemic disease management over T_2 (13.33%).

Integrated disease management for little leaf and phyllody of brinjal

An experiment has been conducting for three consecutive years (2018-2020) in the experimental field of the Agronomy Division, BARI, Gazipur regarding the integrated management for little leaf and phyllody diseases of brinjal. Five treatments with two brinjal cultivars were used in randomized complete block design (RCBD) with 3 replications. There was no disease incidence recorded in 2018 due to less infestation of the vector (leaf hopper). In 2019, the treatment sticky yellow polythene sheet reduced AUDPC (area under disease progress curve) significantly for disease severity compared to non-treated control. However, this year (2020), there was also no disease incidence recorded in the brinjal field.

Survey, isolation and identification of plant-parasitic nematodes of different fruits of Bangladesh

From December 2019 to February 2020, suspected nematode infected root samples of banana and papaya were collected from Gazipur, Rajshahi and Sylhet districts. After the isolation of the nematodes through Baermann-funnel technique, based on the morphology of the nematodes, they were identified as *Hoplolaimus* sp., *Helicotylenchus* sp., *Tylenchu* ssp., and *Tylenchorhynchu* ssp.

Efficacy of fungicudes in controlling white mold disease of french bean

The experiment was conducted at Plant Pathology Division, BARI, Gazipur during *robi* cropping season 2019-20 to evaluate the effectiveness of different groups of fungicides against white mold disease of French bean. Eleven different fungicides, namely $T_{1=}$Carbendazim (Autostin), $T_{2=}$Propiconazole (Tilt 250EC), $T_{3=}$Tebuconazole (Folicur 250EC), $T_{4=}$Difenoconazole (Score 250EC),$T_{5=}$Mancozeb (Indophil M45), $T_{6=}$ Hexaconazole(Contaf 5 EC),$T_{7=}$ Asoxytrobin+Difenoconazole (Amister top 325 SC) ,$T_{8=}$ Mancozeb+Carbendazim (Companion), $T_{9=}$Copper oxychloride (Sunvit50WP), T_{10}=Ipodione (Rovral 50WP), $T_{11=}$Fenamidone+ Mancozeb 600WG (Secure) along with $T_{12=}$ Control treatment were selected with three replications for the experiment. BARI French Bean-1 was used which was considered as susceptable to disease. The experiment was carried out following Randomized Complete Block design with three replications. The unit plot size was 2.4m x 2.1m and the seeds were sown on 9th December, 2019 maintaining proper spacing. Different agronomical practices were applied to the field properly. At *in vitro* condition, the fungicides were used in PDA petri plate with 300 and 500 ppm concentration and normal PDA media as for control. 5 mm block of pure culture of *Sclerotrinia sclerotiarum* was used in every plate and radial myceliL growth was recorded after 3 and 7 days. Due to environnemental effect disease incidence and symptom was found in the field of french bean. There was no application of fungicides in the field. For the *in vitro* conditoin Autostin, Tilt 250EC, Folicur 250EC, Contaf 5 EC, Companion and Rovral 50WP controlled the radial growth of *Sclerotinia sclertiorum* at 300 and 500 ppm.

Evaluation of fungicides against early blight of tomato

The efficacy of some fungicides like Propicarb 70 wp (Propineb 70 wp), Moen 80 wp (Mancozeb 80 wp), Cibalux 75WP (Mancozeb+Carbendazim 75%WP), Joybun 80 WDG (Mancozeb), Azob 80 WDG (Mancozeb80%), Amazan 32.5 WP (Azoxystrobin + Fenoxanil), SC Double Action 76WP (Propineb 70%+Cymoxanil 6%) and one Bio fungicide (Phytosporin) along with commonly used fungicides *viz*., Rovral (Ipridione) and Amister top (Asoxytrobin+Difenoconazole) were tested against early blight of tomato at Plant Pathology Division of BARI during 2019- 2020 cropping season. The seedlings of BARI Tomato -14 were used. Spraying was started immediately after the onset of disease and a total of three sprays were applied at an interval of 12 days. All fungicide treatments reduced the disease intensity as compared to untreated control. The lowest disease incidence was observed in Cibalux 75 WP treated plot which was followed by Rovral sprayed plot and the highest disease incidence was found in Control treatment. The lowest percentage disease index (38.67) was recored in Cibalux 75 WP ` sprayed plot followed by treatment T_5 i.e., Azob 80 WDG and the highest (79.33) was observed in Control treatment. Percent disease reduction ranges from 18.48% to 51.25%, while the lowest disease reduction was recorded from T_{10} (Amister top) treatment and the highest disease reduction was found from T_3 (Cibalux 75 WP) over Control which was followed by T_5 (Azob 80 WDG). The highest yield (65.14 ton/ha) was obtained from T_3 (Cibalux 75 WP) which was followed by Rovral treated plot and T_5(Azob 80 WDG) treatment where lowest was recorded from control treatment i.e., 54.24 ton/ha.

Survey, isolation and identification of major diseases of gerbera flower

A survey was carried out in different Gerbera gardens in Gazipur during November 2019 to January 2020 cropping season. Plant samples (viz. leaf, stem, flower and root) were collected and brought in the plant pathology laboratory for identification of the disease and pathogen following standard method. The isolated pathogen was identified based on morphological characteristics observed under a compound microscope comparing standard keys. Three species of fungi namely *Pestalotia* sp, *Alternaria alternata* and *Fusarium oxysporum.* were isolated from the infected plant parts of Gerbera which were responsible for the Leaf spot, Alternaria leaf spot, and Fusarium wilt diseases of Gerbera, respectively.

Survey, isolation and identification of diseases in tuberose and gladiolus

A survey was carried out in different gardens in Gazipur during November 2019 to January 2020 cropping season. Plant samples (*viz*. leaf, stem, flower, corm and bulb) were collected and observed in the plant pathology laboratory for identification of the disease and pathogen following standard method. The isolated fungi were identified based on morphological characteristics observed under a compound microscope comparing standard keys. Two species of fungi, namely *Alternaria alternata* and *Fusarium graminearum* were isolated from the infected plant parts of Tuberose which caused Alternaria Leaf spot and leaf blight disease. On the other hand, Fusarium wilt and Alternaria leaf spot diseases were found in Gladiolus which caused by fungi i.e, *Fusarium oxysporum* and *Alternaria alternata* , respectively.

Characterization of pathogens for head blight complex of cereals

Head blight complex of cereals has devastating impact on yield and grain quality. Head blight complex of cereals has devastating impact on yield and grain quality, and emerged as a major threat to global food security. Survey was done in Jashore, Pabna, Rajsahi, Rajsahi, Tangail, Noakhali and Patuakhalion wheat, barley, aman rice and boro rice. During this study, head blight incidence was observed 25-42% in wheat, 15-40% in barley 30-50% in aman rice and 37-50% in boro rice. The fungal species *Bipolaris* spp., *Fusarium* spp., Alternaria spp., and Curvularia spp. were isoatled from heads of wheat. The fungal species Magnaporthe spp. and Fusarium spp. were isolated from heads of rice. The isolated pathogens were often co-exists in the same head and in the same field of wheat, barley and rice. High variability was noticed in morphology of *Bipolaris* spp. Phenotyping and genotyping study was done in 2019-20. However, results highlight the need for deployment of effective disease management strategy in those areas.

Management of stem blight and wilt diseases of water melon

An attempt was taken for management of stem blight and wilt diseases of water melon caused by *Dedymela bryoniae* and Fusarium oxysporum by using some fungicides and biocontrol agents at BARI, Gazipur-1706. In the *in vitro* trail we observed that five fungicides from different groups viz. Mancozeb + Metalaxyl, Copper Oxichloride + Metalaxyl, Tebunaconazole + Trifloxostrobin, Pyrachloztrosin + Tebuconazole, Carbendazim, Azoxystrobin +Difenoconozol and two bioagents namely Trichoderma harzianum and Epicoccum sp. completely blocked fungal growth. Based on the preliminary laboratory evaluation, they were selected for the control of stem blight and wilt disease in the field experiment. In the field trial, among the different treatments Copper Oxichloride + Metalaxyl, Copper Oxichloride, Trichoderma harzianum and Epicoccumnigrum was appeared to be superior in controlling the stem blight and wilt of water melon.

Integrated management for controlling of blast diseases of wheat

Rice-wheat is the major cropping system in Bangladesh and the major cereals for food security. *Magnaporthe oryzae* pathotype *oryza* is the rice blast pathogen and *M. oryzae pathotype triticum* is the wheat blast pathogen. Four components were evaluated in 2017-18 at RARS, Jashore for integrated management of blast disease on wheat. The components of seed treatments, splitting of nitrogen fertilizers, foliar spray of additional fertilizers and different groups of fungicidal spray were selected for integrated disease management. Results from four components were integrated in 2018-19 for effective blast disease management of wheat. The lowest disease severity was recorded in the plots treated with Xelora+Opera+Cabrio+SiO_2 and Vitaflow+Opera+Cabrio+SiO_2 followed by Xelora+Opera+Cabrio, Vitaflow +Opera+Cabrio and Trichoderma+Opera+Cabrio+SiO_2. Singly nativo was not good for blast disease control.

Management of bacterial wilt disease of brinjal

An attempt was taken for the management of wilt of brinjal caused by *Ralstonia solanacearum* by using different treatments at BARI, Gazipur 2019-20. In the *in vitro* trail we observed that Bleaching powder, Calcium nitrate and Bismerthiazol (Bactrol) did not show any effect against *R. solanacearum*, when Bacilus subtilis, Polythine covered ridge bed +Trichoderma harzianum, Epicocum nigram, Streptomycin sulfate+ Tetracycline hydrochloride, Streptomycin sulfate, Bismerthiazol and Oxytetracycline hydrocloride completely blocked bacterial growth. Based on the preliminary laboratory evaluation, those treatments were selected for the control of bacterial wilt disease of brinjal in the field experiment. In the field trial, among the different treatments Bacilus subtilis, Polythine covered ridge bed +Trichoderma harzianum, Epicocum nigram, Bismerthiazole and Streptomycin sulfate+ Tetracycline hydrochloride were appeared to be superior in controlling the wilt of brinjal and also significantly increased the yield.

Integrated management of *cucumber mosaic virus* of chilli (*Capsicum annum* L.)

Chilli (*Capsicum annuum* L.), belongs to the family Solanaceae is an important vegetable and spice crop having immense commercial importance. It is one of the most important crops grown worldwide and cultivated in the Indian sub-continent for vegetable, spice and industrial purposes

An experiment was conducted to find out the effective management option against CMV of chilli. BARI Marich-1 was planted at the research field of Plant Pathology Division, BARI Gazipur on December 2019 with three replications. Significant variation of disease incidence and severity was found in different treatment packages. Disease incidence and severity ranged from 10.20 to 37.75 % and 1.0 to 4.0 in different treatment packages. The lowest disease incidence and severity was found 10.20 and 1.0, respectively in treatment package T_1 (Net in seed bed + one spray of Imidacloprid 0.1% at 5 days before transplanting + Sticky yellow trap in the plot + 3 sprays of Imidacloprid 0.1% at 15 days interval starting after observing the vector population by yellow trap) followed by T_2 (Net in seed bed + one spray of Bio-Neem instead0.2 % at 5 days before transplanting + Sticky yellow trap in the plot + 3 sprays of Bio-Neem 0.2% at 15 days interval starting after observing the vector population by yellow trap) where disease incidence and severity was 10.95 and 1.0, respectively. The highest yield (14.72 t/ha) was recorded from T_1 followed by T_2 (14.44 t/ha). The reduction of disease incidence was found 72.98 % and 70.99 % in treatment T_1 and T_2 respectively and maximum increase of yield 65.15 and 64.75 % was found in the same treatment packages. Two treatment packages T_1 and T_2 were considered as the best management option on the basis of minimum disease incidence, higher yield and marginal benefit cost ratio (6.15 & 5.75), respectively. Marginal cost benefit analysis indicated that the two management packages (T_1 & T_2) were economically viable and cost effective. However, these management packages could be used as effective options for management of CMV infecting chilli in Bangladesh.

Evaluation of okra varieties resistant to *okra yellow vein mosaic virus* (OKYVMV)

Okra (*Abclmoschus esculentus*) is an important commercial vegetable crop grown throughout the world. It is commonly known as lady finger. *Okra yellow vein mosaic virus* (OYVMV) is a major and devastating pathogen of Okra, significantly lowers the yield up to 94%. Nineteen varieties/cultivars were screened against OYVMV during the year of 2020. The experiment was laid out in RCBD with three replications. Out of 19 varieties/lines, two varieties/lines (OK-12 and OK-19) showed resistant response against the virus. Four varieties/lines (OK-03, OK-05, OK-06 and OK-18) showed tolerant reaction against OYVMV. OK-02, Ok-04, OK-13, OK-15, OK-16 and OK-17 showed moderately susceptible reaction against the virus. OK-09, OK-11 and OK-14 fall under the category of susceptible. Three varieties/linesOK-07, Ok-08 and Ok-10 came out as highly susceptible. Resistance source may be use as variety or as resistant breeding materials for varietal development.

Screening of organic composts for mass culturing of *Trichoderma harzianum* to be used against soil-borne pathogen *Sclerotium rolfsii* and *fusarium oxysporum* of chickpea

Chickpea (*Cicer arietinum* L.) is an important legume crop in the semi-arid tropics of the world and it is the third major pulse crop in Bangladesh. Diseases including foot & root rot and wilt diseases are the major limited factor for the chickpea production in Bangladesh. So, the present research was taken to observe the suitability of organic compost and vermi-compost for mass culturing of bio-control agent, *Trichoderma harzianum* and its effectiveness against foot & root rot and wilt diseases of chickpea caused by *Sclerotium rolsfii* and *Fusarium oxysporum*. The experiment was conducted in the field of Plant Pathology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur with 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 formulated *T. harzianum* cultured in two different compost *viz*. organic compost and vermin-compost are designated as Tricho-organic-compost and Tricho-vermi-compost. The experimental field soils were inoculated with *S. rolfsii* colonized substrates @ 100g/m^2 soil before seed sowing. Tricho-composts were added @ 3 t/ha after inoculation with pathogens. Seeds were treated with Provax @ 2.5 g/kg seeds before seed sowing. BARI Chola-5 variety was used in this study. Results of the present study revealed that all the treatments had significatnt effect against foot & root rot and wilt diseases of chickpea and increasing plant growth parameters such as shoot height, shoot weight, root length and root weight of chickpea as well as yield of chickpea compaered to control. Among the treatments soil amendment with Tricho-vermi-compost and Tricho-organic-compost were considered to be the best treatments in reducing seedling mortality (reduced 69.67% and 68.90%, respectively than control) and in increasing plant growth parameters as well as yield (gave 34.50% and 354.07% higher yield compared to control) of chickpea. Seed treatment with Provax showed better performance against the disease and its effect was similar the soil amendments with organic compost and vermi-compost in reducing seedling mortality and increasing plant growth and yield of chickpea. From this study it may be concluded that soil amendment with Tricho-organic-compost and Tricho-vermi-compost are to be the best treatment for management foot & root rot and wilt diseases of chickpea and getting higher yield of chickpea than control. Seed treatment with chemical fungicide Provax was also better treatment for management foot & root rot and wilt diseases of chickpea.

Screening of composts and biochars against seedling disease caused by *Sclerotium rolfsii* of barley

Tricho-compost, composts and biochars have the potential to improve soil fertility and crop productivity. A field experiment was conducted at the experimental field of Plant Pathology Division, Bangladesh Agricultural Research Institute, Gazipur during 2019-20 cropping season to observe the efficacy of Tricho-compost, vermin-compost, organic compost and three different biochars *viz.* biochar-1, biochar-2 and biochar-3 against soil borne pathogen *Sclerotium rolfsii* of barley. The field soil was inoculated with *S. rolfsii* colonized substrate @ 100g/m^2 of soil and allowed the pathogen establishment in the soil for 7 days. Then the *S. rolfsii* inoculated soil was challenged with organic compost, vermi-compost, Tricho-compost and biochars @ 3 t/ha were kept for 5 days. In case of chemical treatment, seeds were treated with Provax @ 2.5 g/kg seeds before seed sowing. The seeds of barley *var*. BARI Barley-2 were sown @ 100 kg ha^{-1} in the experimental plots with maintaining row to row distance of 20 cm. Proper intercultural operations were done for better growth of barley in the field. Results from this study revealed that all the treatment had significant effect in reduction of seedling disease ranged from 47.45% to 68.62% of barley compared to control caused by soil borne pathogen *S. rolfsii* and increasing the plant growth parameters such as shoot height, shoot weight, root length and root weight and gave 31.70% to 46.13% higher yield of barley compared the control. Seed treatment with Provax was found similar effect for reducing seedling mortality and enhancing plant growth and yield of barley. The findings revealed that utilization of Tricho-compost, composts and biochars had positive effect on the improvement plant growth and crop productivity as well as disease suppression of barley.

Screening of composts and biochars against seedling disease caused by *Sclerotium rolfsii* and *Fusarium oxysporum* of lentil

Lentil (*Lens culinaris*) is the second major pulse crops of Bangladesh in respect of acreage and production. Diseases are one of the most important factors for mortality of the plant and yield losses. Among the major of pathogens, *Fusarium* oxysporum and *Sclerotium rolfsii*, causing foot and root rot disease of lentil. Sometimes it causes about 100% yield loss. Therefore, the present study conducted to screen the available biochars and composts against against foot and root rot disease of lentil. A pot experiment was conducted in the pot house of Plant Pathology Division, BARI, Joydebpur, Gazipur during 2019-20 with 8 treatments *viz*. (i) seed treatment with Provax (ii) soil amendment with organic compost (iii) soil amendment with vermin-compost (iv) soil amendment with Tricho-compost, (v) soil amendment with biochar-1 (vi) soil amendment with biochar-2 (vii) soil amendment with biochar-3 and (viii) control. Sterilized soil was inoculated with *S. rolfsii* and *F. oxysporum* colonized mixture of Grasspea and wheat bran along with mustard oilcake substrates @20 g/kg soil and kept 7 days for pathogens multiplication. Then the *S. rolfsii* and *F. oxysporum* inoculated soil was challenged with organic compost and vermi-compost @ 100 g/kg soil. Tricho-compost and biochars were used @ 5% (w/w). In case of chemical treatment, seeds were treated with Provax @ 2.5 g/kg seeds before seed sowing. CRD design was followed with 5 replications. Results of the present study revealed that soil amendment with Tricho-compost, vermi-compost, organic compost, biochar-1, biochar-2 and biochar-3 are effective for reducing seedling mortality range from 52.40% to 74.41% compared to control and increasing seed germination and plant growth of lentil under pot house condition. Seed treatment with Provax was also better treatment for management of foot and root rot disease of lentil. This is first year experiment so further study is needed for confirmation the results.

Screening of composts and biochars against root-knot nematode *Meloidogyne incognita* of tomato

Tomato *(Solanum lycopersicon* L.) is one of the important and popular vegetables in Bangladesh. Several yield limiting factors of tomato are enumerated. Among them diseases caused by fungi, bacteria, nematodes and viruses play major role. The root-knot disease caused by *Meloidogyne incognita* is highly damaging and yield reducing factor of tomato throughout the country. Therefore, the present study was under taken to observe the effect of biochars and organic compost on root-knot nematode infestation of tomato. The experiment was conducted in the pot house of Plant Pathology Division, BARI with 8 treatments *viz*. (i) Furadan 5 G @ 5 g/kg soil (ii) soil amendment with organic compost @ 100 g/kg soil (iii) soil amendment with vermin-compost @ 100 g/kg soil (iv) soil amendment with Tricho-compost @ 5% (w/w) soil (v) soil amendment with biochar-1 @ 5% (w/w) soil (vi) soil amendment with biochar-2 @ 5% (w/w) soil (vii) soil amendment with biochar-3 @ 5% (w/w) soil and (viii) control. CRD design was followed with 5 replications. To ensure inocula of the nematode, chopped severely galled tomato roots infected with *M. incognita* were mixed with sterilized soil @ 5 g/kg soil. Organic compost, vermi-compost, Tricho-compost and biochars were added in the pot soil 7 days before seedling transplanting. In case of chemical treatment, Furadan 5G was added in the pot soil at the time of seedling transplanting. Twenty five days old and apparently tomato seedlings of variety BARI Tomato-15 were transplanted in the pot and each pot received 5 seedlings. During crop season necessary weeding, irrigation and other intercultural operations were done as per recommendation of the crop. Results from the present study revealed that soil amendment with Tricho-compost, vermi-compost, organic compost, biochar-1, biochar-2 and biochar-3 gave appreciable reduction of gall development on roots of tomato caused by root knot nematode *M. incognita* and increased plant growth parameters such as shoot and root growth of tomato. Among the treatments, soil amendment with Tricho-compost appeared to be the best amended materials for reduction of root knot nematode disease incidence and improvement of plant growth. Soil amendments with vermi-compost, organic compost, biochar-1, biochar-2 and biochar-3 also appeared better treatment for reduction of root knot nematode disease incidence and improvement of plant growth of tomato compared to control and chemical nematicide Furadan 5G.

Development of biorational management package against root knot nematode and bacterial wilt of tomato

Tomato *(Solanum Lycoperscicum* L.) is one of the most popular and important commercial vegetable crops grown throughout the world including Bangladesh. The root-knot disease caused by *Meloidogyne incognita* and bacterial wilt caused by *Ralstonia solanacearum* are soil borne pathogens and major limiting factor in the production of tomato throughout in the world including Bangladesh. Chemical control of these diseases is hardly successful. So, the present study was undertaken to develop biorational based eco-friendly integrated management packages against root knot and bacterial diseases of tomato. The experiment was conducted during *rabi* 2019-20 in the field of Plant Pathology Division BARI, Joydebpur, Gazipur. There were 7 treatments *viz*. (i) BARI Tricho-vermi-compost+ Dynamic (bio-fungicide) (ii) Soil recharge + Dynamic (bio-fungicide) (iii) Soil recharge + BARI Tricho-vermi-compost (iv) Decoprima (bio-fungicide) (v) Decoprima (bio-fungicide) + Soil recharge (vi) Decoprima (bio-fungicide) + Tricho-vermi-compost (vii) Farmers practices. The experiment was laid out in a randomized complete block design with 3 replications. The field soil were inoculated with @ 1 gm galled chopped roots of Indian spinach per plant at the time of seedling transplanting. Root knot nematode infested field soils were treated with different combination of *Trichoderma* based Tricho-compost with commercial biofungicide Decoprima, Dynamic and Soil recharge and also integration of Soil recharge with Decoprima and Dynamic. The variety BARITomato-15 was used in this study. During this year bacterial disease was not observed in the experiment field. Results from this study revealed that all the treatments gave appreciable reduction of gall development on roots range from 57.96% to 65.37% over control and increased plant growth parameters such as shoot and root growth as well as gave 36.02% to 46.28% higher yield of tomato compared to control. Among the treatments, integration Tricho-compost with Decoprima and Soil recharge as well as integration of Soil recharge with Decoprima are the best treatments which reducing 62.96% and 65.37%, respectively root-knot nematode disease severity compared to control and increasing plant growth parameters. These treatments also gave 44.46% and 46.28%, respectively higher yield of tomato compared to control. Integration of Tricho-compost with Dynamic, Soil recharge with Dynamic and bio-fungicide Decoprima alone were also better in reducing root knot nematode disease incidence and increasing plant growth as well as yield of tomato.

Development of biorational management package against root knot nematode and bacterial wilt of eggplant

Brinjal (*Solanum melongena* L.) is an important vegetable crop in all over the World especially in south Asia (Bangladesh, India, Nepal and Sri Lanka). But the yield is quite low in Bangladesh compared to other country. Several diseases caused by fungi, bacteria, nematodes and viruses play major role in reducing yield per unit area. Among the diseases Bacterial wilt caused by *Ralstonia solnacearum* and root-knot nematode disease caused by *Meloidogyne spp.* is highly damaging and yield reducing factor throughout the country. So, the present study was undertaken to develop biorational based management packages against root knot and bacterial diseases of eggplant. The experiments were conducted in the field of Plant Pathology Division, BARI during 2019-20 cropping season to develop eco-friendly integrated management technology against bacterial wilt caused by *Ralstonia solanacearum* and root knot nematode caused by *Meloidogyne incognita* diseases of eggplant. There were 7 treatments *viz*. (i) BARI Tricho-vermi-compost+ Dynamic (bio-fungicide) (ii) Soil recharge + Dynamic (bio-fungicide) (iii) Soil recharge + BARI Tricho-vermi-compost (iv) Decoprima (bio-fungicide) (v) Decoprima (bio-fungicide) + Soil recharge (vi) Decoprima (bio-fungicide) + Tricho-vermi-compost (vii) Farmers practices. The experiment was laid out in a randomized complete block design with 3 replications. The field soil were inoculated with @ 1 gm galled chopped roots of Indian spinach per plant at the time of seedling transplanting. Root knot nematode infested field soils were treated with different combination of *Trichoderma* based Tricho-compost with commercial biofungicide Decoprima, Dynamic and Soil recharge and also integration of Soil recharge with Decoprima and Dynamic. The variety BARI Begun-4 was used in this study. During this year bacterial disease was not observed in the experiment field. Results from this study revealed that all the treatments gave appreciable reduction of gall development on roots range from 58.25% to 63.28% compared to control and increased plant growth parameters such as shoot and root growth as well as also gave 34.65% to 47.62% higher yield of eggplant than control. Among the treatments, integration Trichoderma based bio-fungicides Tricho-composts with Decoprima and Soil recharge as well as Soil recharge with Decoprima are the best treatments in reducing root-knot nematode disease as well as increasing plant growth and yield of eggplant. Integration of Tricho-composts with Dynamic, Soil recharge with Dynamic and bio-fungicide Decoprima alone were also better in reducing root knot nematode disease incidence and increasing plant growth as well as yield of eggplant.

Development of bio-rational based disease management package against powdery mildew and root knot nematode diseases of cucurbits during rabi season

Different groups of vegetables are cultivated in Bangladesh. Among them, the cucurbits form an important and big group of vegetable crops cultivated extensively in Bangladesh. Cucurbits crops are variably attacked by economically important diseases. Among them, the root- knot nematodes (*Meloidogyne* spp.) adversely affect both yield as well as quality of cucurbits. Cucurbits are susceptible to most common root knot nematode species, under favorable condition which can reduce yield up to 60% in commercial protected cultivation. On the other hand, powdery mildew is common and devastating some times. Use of chemical nematicides and fungicides to control these diseases always poses a serious health hazards and environmental pollution. Hence, attempts were made to develop bio-rational based management packages of these diseases of bottle gourd and pumpkin in the field. The experiments were conducted in the field of Plant Pathology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. There were 4 treatments *viz*. (i) Tricho-vermi-compost @ 2 kg/pit + Bordeaux mixture/Sulpher fungicide (ii) Soil recharge + Fizimite (bio-fungicide) (iii) Decoprima (bio-fungicide) + Vegard (bio-fungicide) (iv) Farmers practices. Root knot nematode infested pit soils were treated with different treatment *viz*. Tricho-vermi-compost fungicide, Soil recharge and Decoprima (bio-fungicide). During this year powdery mildew was not observed in the experimental field. So, Bordeaux mixture/Sulpher fungicide, Fizimite (bio-fungicide) and Vegard (bio-fungicide) were not applied in the field. Results from this study showed that all the treatments gave appreciable reduction of root knot gall development on roots and increased plant growth parameters such as shoot and root growth as well as yield of bottle gourd and pumpkin. Soil amendment with Tricho-vermi-compost reduced 68.44% root knot disease severity compared to farmer’s practices followed by soil treatment with Soil recharge and Decoprima where the reduction of disease severity was 61.11% and 46.22%, respectively compared to farmers’ practices. Yield of pumpkin was higher 45.03% compared to farmers’ practice due to application of Tricho-vermi-compost whereas it was 37.34% and 36.89% due to application of Soil recharge and Decoprima, respectively. In case of bottle gourd, soil amendment with Tricho-vermi-compost reduced 67.88% root knot disease severity compared to control followed by soil treatment with Soil recharge and Decoprima where the reduction of disease severity was 62.10% and 57.82%, respectively compared to farmers' practices. Yield of bottle gourd was higher 55.78% compared to farmers' practice due to application of Tricho-vermi-compost whereas it was 48.11% and 47.13% due to application of Soil recharge and Decoprima, respectively. From these studies, it may be concluded that soil amendment with Tricho-vermi-compost, the best treatment followed by soil treatment with Soil recharge and Decoprima bio-fungicide for reducing root-knot disease, as well as increasing plant growth and receiving higher yield of bottle gourd and pumpkin.

Development of bio-rational based disease management package against root knot nematode and powdery mildew diseases of cucurbits during *kharif* season

Cucurbits are important and big group of vegetable crops cultivated extensively in Bangladesh. This group includes bitter gourd, bottle gourd, white gourd, ridge gourd, cucumber, muskmelon, watermelon, pumpkin, squashes, pointed gourd, snake gourd and large number of trailing crops belonging to the family cucurbitaceae. Cucurbits crops are variably attacked by economically important diseases. Among the diseases, root knot nematode caused by *Meloidogyne incognita* and powdery mildew caused by *Erysiphe cichoracearum* diseases are the major constraints for cucurbits cultivation. Use of chemical nematicides and fungicides to control these diseases always poses a serious health hazards and environmental pollution. Thus the development of alternative control strategies and long-term integrative approaches is urgently needed in order to replace chemical nematicides Hence, attempts were made to develop bio-rational based integtrated management packages of root knot nematode and powdery mildew diseases cucurbits in the field. The experiments were conducted in the field of Plant Pathology Division, BARI during *kharif* 2018-19 cropping season to develop eco-friendly integrated management technology against root knot nematode caused by *Meloidogyne incognita* and powdery mildew caused by *Erysiphe cichoracearum* diseases of pumpkin, white gourd, cucumber and ridge gourd. Root knot nematode infested field soils were treated with different treatment *viz*. (i) Tricho-organic-compost @ 2 kg/pit + + Tricho-spores (ii) Tricho-vermi-compost @ 2 kg/pit + + Tricho-spores (iii) Tricho-organic-compost @ 2 kg/pit + Furadan 5 G @ 15-20 g/pit + Bordeaux mixture/Sulpher fungicide (iv) Tricho-vermi-compost @ 2 kg/pit + Furadan 5 G @ 15-20 g/pit + Bordeaux mixture/Sulpher fungicide (v) Mustard oil cake @ 1 kg/pit + Furadan 5 G @ 15-20 g/pit + Bordeaux mixture/Sulpher fungicide (vi) Saw dust burning + Furadan 5 G @ 15-20 g/pit + Bordeaux mixture/Sulpher fungicide (vii) Farmers practices. Results showed that all the treatments gave appreciable reduction of powdery mildew disease and root knot gall development on roots and increased plant growth parameters such as shoot and root growth as well as yield of pumpkin, white gourd, cucumber and ridge gourd. In case of powdery mildew, alternative foliar applications of Bordeaux mixture and Sulpher fungicide effectively control powdery mildew disease pumpkin, white gourd, cucumber and ridge gourd during kharif season. In case of root knot nematode disease, all the treatments significantly reduced root knot disease severity and increasing plant growth parameters such as shoot height, shoot weight, root length and root weight as well as yield of pumpkin, white gourd, cucumber and ridge gourd during kharif season. Among the treatments, integration of Tricho-vermi-compost with Furadan 5G, MOC with Furadan 5G and foliar application of Bordeaux mixture/Sulpher fungicide or/and integration Tricho-organic-compost with Furadan 5G and Bordeaux mixture/Sulpher fungicide or/and integration SDB with Furadan 5G and Bordeaux mixture/Sulpher fungicide are the best treatment for thr management of powdery mildew and root knot nematode diseases and increasing plant growth parameters as well as yield of pumpkin, white gourd, cucumber and ridge gourd. Integration of Tricho-vermi-compost with Tricho-spores and Tricho-organic-compost with Tricho-spores are only effective against root knot nematode disease and also and increasing plant growth parameters as well as yield of pumpkin, white gourd, cucumber and ridge gourd.

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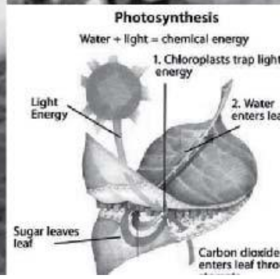

Physiological response of selected rapeseed/mustard genotypes to salinity stress

An experiment on rapeseed/mustard genotypes was conducted during 2018-2019 and 2019-2020 rabi season at the Pot house of Plant Physiology Division, BARI, Gazipur to find out salt tolerant genotypes. Five selected rapeseed/mustard genotypes (Jun-536, BJDH-12, BD-10115, BARI-14 and BD-6950) were tested under three salinity levels (0, 5 and 10 dS/m). Salinity was imposed at 20 days after sowing by adding NaClsolution. Salt solution was applied with an increment of 5dS/m in every alternate day until desired salinity levels were attained. In control treatment, pond water was used which salinity levels was 0.2 dS/m. Salinity levels were maintained by monitoring (with EC meter) and adding salt solution when required up to maturity. The experiment was laid out in randomized complete block design with 5 replications. Plastic pots (top dia: 25 cm, bottom dia: 18 cm and height 25 cm; 12 kg soil) were filled up with soil and cowdung (4:1). Seeds were sown in each pot on 11 November in 2018 and 12 November in 2019. Fertilizers were applied @100-30-80-20-3-1 kg/ha NPKSZnB. Half of N and all other fertilizers were applied as basal and remaining N was applied at 20 days after sowing (DAS). Irrespective of the genotypes, with the increase of salinity levels physiological parameters as well as seed yield were greatly affected. Leaf chlorophyll content did not show any remarkable variations due to salinity stress. However, leaf area, leaf photosynthetic rate; total dry matter (TDM) was reduced due to salinity stress which ultimately reduced seed yield irrespective of the genotypes. Sodium and potassium ion content and their ratios (K^+/Na^+) in leaf tissue were significantly affected by salinity with significant variability in genotypes. Among the genotypes, Jun-536 and BJDH-12 showed higher K^+/Na^+ ratio in leaf, which indicate higher tolerance to salinity compared to others under both the salinity levels. The higher catalase (CAT) and peroxidase(POD) activity was found in Jun-536 and BJDH-12 genotypes but Malondialdihyde (MDA) content was lower under salinity stress compared to others which also indicate their better tolerance to salinity. These genotypes also showed higher leaf photosynthetic rate, TDM production and seed yield under both the salinity levels compared to other genotypes. Results from two years revealed that Jun-536 and BJDH-12 can be considered as tolerant genotypes against salinity stress.

Effect of high temperature stress at different growth stages of winter onion

A pot experiment was conducted at the Pot house of Plant Physiology Division, BARI Gazipur during rabi season of 2018-2019 and 2019-2020 to evaluate the effect of high temperature stress on physiological and biochemical changes in winter onion. In 2018-2019 four treatments namely T_1= open field (control), T_2= Inside polythene chamber from 20 days after transplanting (DAT) to 35 DAT, T_3= Inside polythene chamber from 35 DAT to maturity, T_4= Inside polythene chamber from 20 DAT to maturity were used in the study while in 2019-2020 one more treatment i.e. T_5= Inside polythene chamber from transplant to maturity were included. High temperature was imposed by polythene covered chamber where temperature was 1.5 to 5.5 ºC higher (depending on time of the day) than outside of the chamber. 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 25 cm; 12 kg soil) was filled up with soil and cowdung (4:1). Ten seedlings (40 days old) of BARI Piaj-1 were transplanted in plastic pots on 2nd January in 218 and 19 December in 2019. Fertilizers were applied 90-45-120-30-3-1.4 kg/ha of N P KSZnB. Half of N and half of K along with full amount of other fertilizers were applied as basal. Remaining N and Kwas top dressed in 2 equal splits at 25 & 50 DAT. After 10 DAT, plants were thinned to five plants in each pot. In the first year, leaf chlorophyll content, leaf area, total dry matter production (TDM) and bulb yield was significantly reduced due to high temperature stress; however, there exists variability among the treatments. Leaf area and TDM was significantly reduced in T_3 and T_2 treatments compared to control and T_4 treatments. Antioxidant activities (Catalase, Ascorbate peroxidase, Peroxidase) and Malondialdehyde were found more in T_3 and T_2 treatments indicating that plants in these two treatments faced more temperature stress than others. Consequently, higher bulb yield reduction (24.12%) was found in T_3 treatment followed by T_2 and the lowest in T_4 (8.17). But in the 2nd year, higher temperature showed positive impact on growth parameter and bulb yield in all the treatments except T_2 treatment where a slight decrease in yield was observed (3.19%). So, the experiment needs to be repeated for confirmation of the results.

Physiological responses of wheat genotypes under drought condition

Drought significantly reduces yield of many crop plants including wheat in the world. Vinyl house pot experiments were conducted to investigate genotypic differences in response to drought stress advance wheat genotypes (BWSN 31, drought tolerant; BWSN 33, drought sensitive) and cv. BARI Gom-33 of Plant Physiology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during the November, 2019 to March 2020. Ten seeds of each genotype were sown in each pot on 22 November 2019. Thinning of seedling was done by keeping five plants for each pot at 10 day after emergence. Drought treatment was imposed during late vegetative stage. This experiment included the following 2 treatments: (1) control (no drought), in which pots remained humid (at a 50-60% water holding capacity) throughout; (2) drought stress (D) treatment, the plants were then subjected to drought stress from late vegetative stage to reproductive stage by withholding irrigation. The experiment was done in Randomized complete block design (RCBD) with nine replications. Then plastic pots (10 L, 30 cm height) were filled with the mixture of air-dried soil and cow dung in 4:1 volume ratio. The soil was acidic in nature (pH 6.1). Fertilizer at the rate of 120-30-90-15-6-2-1 kg/ha NPKSMgZnB (FRG, 2018) in the form of Urea, Ttriple super phosphate, Muriate of potash, Gypsum, Zinc sulphate and Boric acid were incorporated in the soil as follow the pot method.The results showed that drought decreased plant growth, chlorophyll content and photosynthesis parameters. Drought stress significantly decreased free water content and relative water content in leaves with the least decrease in the tolerant genotypes, while increased the bound water content with the least increase in the tolerant genotypes. Under drought stress, genotypes BWSN 31 were less suppressed than that of BWSN 33 and BARI Gom-33. Moreover, much more increase in activities of catalase (CAT), guaiacol peroxidase (POD), ascorbate peroxidase (APX) under drought vs control were observed in BWSN 31 followed by BARI Gom-33 than that of BWSN 33, with less accumulation of malondialdehyde (MDA) and cell membrane stability index (CMSI). Soluble protein and soluble sugars increased significantly in BWSN 31 compared to other genotypes under drought stress conditions. Compared with control, drought stress treatment significantly reduced grain yield and 1000-grain weight; however, BWSN 31 and BARI Gom-33 were less affected than BWSN 33. These results suggested that high tolerance to drought stress of BWSN 31 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 variety/ 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. Three selected wheat genotypes, namely, BWSN-31, BWSN-33 and BARI Gom-33 were sown in vinyl house of Plant Physiology Division, Bangladesh Agricultural Research Institute, Gazipur, on 22 November, 2019. 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. The soil was air-dried and mixed daily until 8% water content was reached. Air-dried soil was sieved then plastic pots (8 L, 25 cm height) were filled with the mixture of air-dried soil and cow dung in 4:1 volume ratio. The soil was clay loam and acidic in nature (pH 6.1). Fertilizer at the rate of 120-30-90-15-6-2-1 kg/ha NPKSMgZnB (FRG, 2018) in the form of Urea, Ttriple 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 22 November 2019. Thinning of seedling was done by keeping five plants for each pot at 10 day after sowing. The experiment was arranged in Randomized complete block design (RCBD) with nine replicates. The results showed that elevated temperature decreased plant growth, chlorophyll content, net photosynthetic rate (Pn), stomatal conductance (Gs), intercellular CO_2 concentration (Ci) and transpiration rate (Tr), with the largest suppression in BWSN 33. Elevated temperature cuts back the duration of grain filling by 5 days in BWSN 31 and BARI Gom-33 and 10 days in BWSN 33. Moreover, much more increase in activities of catalase (CAT), guaiacol peroxidase (POD), ascorbate peroxidase (APX) under elevated temperature *vs* control were observed in BWSN 31 followed by BARI Gom- 33 than that of BWSN 33, with less accumulation of malondialdehyde (MDA) and CMSI. Soluble protein and soluble sugars increased significantly in BWSN 31 and BARI Gom-33 compared to BWSN 33 under elevated temperature conditions. However, in response to elevated temperature, grain weight was less affected in BWSN 31 and BARI Gom-33 compared to BWSN 33 indicating their better tolerance to elevated temperature.

Screening of wheat for salinity stress at early stages of plant growth

Soil salinity is a major limiting factor for wheat production in Bangladesh. In order to evaluate the salt tolerance characteristic of wheat germplasms, we carried out a hydroponic evaluation of diverse germplasms i.e. using 150 wheat accessionsin a rooftop of Plant Physiology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during the November, 2019 to March 2020. Healthy seeds were surface sterilized by soaking in 2% H_2O_2 for 30 min, rinsed in tap water, and then germinated in moist filter paper in an incubator at 20 ± 1ºC. At the first leaf stage (7 days old), uniformly healthy plants were selected and transplanted to 60L reservoir containers containing 50L basal nutrient solution (mgl^{-1}): KNO_3, 6.5 mM; Ca $(NO_3)_2.4H_2O$ 4.0 Mm as stock solution A, $NH_4H_2PO_4$ 100 µM, $MgSO_4.7H_2O$, 2.0 mM as stock solution B, $MnCl_2.4H_2O$, 0.5 µM; $ZnSO_4.7H_2O$, 0.2 µM; $CuSO_4.5H_2O$, 0.02 µM; H_3BO_3, 4.6 µM; $(NH_4)_6Mo_7O_{24}.4H_2O$, 0.1 µM. The container was covered with 40 small pots and placed in a net house. Take a seed carefully with the tweezers and place it coleoptile facing up, about 2-3cm deep in the centre of the pot and cover gently with a layer of small clay beads. Insert label into the pot. Repeat for all pots. The pH of the solution was adjusted to 6.0 ± 0.1 with NaOH or HCl as required. All solution was changed weekly. Salinity was supplied to seven-day old plants, adding it incrementally by 50 mMNaCl per day to reach a final concentration of 150 mM. Control plants were grown under the same conditions without NaCl. The nutrient solution was aerated with pumps every 30 min interval. The experiment was done in Randomized complete block design (RCBD) with five replications. Results from the hydroponic experiment showed that shoot length (SL), root length (RL), fresh weight (FW) and biomass of shoot/root were significantly reduced in plants exposed to salinity stress (150 mMNaCl) compared with control plants. There were significant differences among the 150 wheat accessions in terms of the reduction in these growth parameters, with variation coefficients and diversity indexes ranging from 18.1 to 45.2% and 1.43 to 1.65, respectively, suggesting a rich genetic diversity among the tested accessions. Venn diagram analysis of the 150 accessions 26 accessions showed the least reduction, indicating their high tolerance to salinity stress. The trends in the different responses of these accessions to salinity stress were fairly consistent with Cluster dendrogram and genotype correlation results. Further screening and evaluation of salt tolerance mechanisms in these superior wheat accessions will help us to understand the potential of wheat progenitors in the development of more salt-tolerant varieties.

Morpho-physiological responses to salinity stress in soybean varieties

Glycine max(L.) *Merr*.has a tremendous value in agriculture as a good source of high quality plant protein and vegetable oils in one hand and nitrogen fixing ability on the other, now a day largely growing in coastal saline prone areas of Bangladesh. The aim of this study was to determine morphological and physiological responses of soybean varieties (Shohag, BARI Soybean 5 and BINA Soybean 4) when subjecting pot grown plants to different concentrations of salinity level i.e. control (0.3), 4, 8 and 12 dS m^{-1} during 2019-20. Salinity was imposed at 30 days after sowing (DAS) by adding NaCl solution. Salt solution was prepared by dissolving calculated amount of lab grade NaCl with pond water. Salt solution was applied with an increment of $5dSm^{-1}$ in every alternate day until desired salinity levels were attained. Plastic pots (top dia: 25 cm, bottom dia: 18 cm and height 25 cm; 12 kg soil) was filled up with soil and cow dung (4:1). Seeds were sown in each pot on 15 December 2019. Fertilizers @30-30-80-20-3-1 kg^{-1}ha NPKSZnB (FGR, 2012) in the form of Urea, Triple super phosphate (TSP), Muriate of potash (MoP) Gypsum, Zinc sulphate and Boric acid, respectively were incorporated in the soil as followed the pot method. Irrespective of the variety, with the increase of salinity levels physiological parameters as well as seed yield were greatly affected. Salinity stress decreased total chlorophyll (Chla+b) and carotenoids (Car). Simultaneously, leaf area (LA) and total dry matter (TDM) was reduced due to salinity stress, which ultimately reduced seed yield irrespective of the genotypes. Sodium (Na^+), calcium (Ca^{2+}) and potassium (K^+) ion content and the potassium sodium ratios (K^+: Na^+) in leaf tissue were significantly affected by salinity with significant variability in variety. Among the varieties, BARI Soybean 5 showed higher K^+: Na^+ ratio in leaf, which indicate higher tolerance to salinity compared to others under every salinity levels. This variety also showed higher leaf area, TDM production, yield contributing traits and seed yield in all salinity levels compared to other varieties. Results revealed that, BARI Soybean 5 showed relatively tolerant against salinity stress compared to Shohag and BINA Soybean 4.

Screening of brinjal genotypes against salinity at seedling stage

Brinjal is an important vegetable crop that provides valuable nutrition to human diet. Salinity, however is severely limiting its production. Therefore, to evaluate the effect of salinity on different brinjal genotypes a hydroponic experiment was conducted, in context to screen-out the salinity tolerant variety during the *rabi* season of 2019-20. For this purpose, 37 day-old seedlings of seventeen brinjal genotypes were grown under three levels of salinity stress (0, 100 and 150 mMNaCl) for 18 days, following completely randomized design (CRD) with three replications. The results showed that increasing levels of salinity significantly decreased all growth parameters of brinjal genotypes, however, reduction rate was less noticeable in SM-5, SM-11, SM-203, SM-221 and SM-233 genotypes. Moreover, these genotypes accumulate more K^+:Na^+ ratio and K^+ ion with less Na^+ ion under salinity condition, compared to other genotypes. Results also revealed that, SM-5, SM-11, SM-203, SM-221 and SM-233 genotypes responded positively in salinity tolerance index and visual performance. Therefore, it may be suggested that SM-5, SM-11,SM-203, SM-221 and SM-233 genotypes should be evaluated in coastal saline area to enhance brinjal production.

Screening of pumpkin genotype for salinity tolerance at vegetative stage

Pumpkin is considered as one of the leading vegetable crop around the world for the nourishment of human being as source of nutrients, minerals, and vitamins. However, the production of pumpkin crop is severely reduced due to salinity stress. Therefore, a hydroponic experiment was conducted to identification of salt tolerant pumpkin genotypes during the *rabi* season of 2019-20. Thirteen pumpkin genotypes were evaluated under three salinity levels (0, 100 and 150 mM). The experimental design was completely randomized design (CRD) with three replications. Irrespective of the genotypes, with the increase of salinity levels showed remarkable variations on growth, biomass production, salinity tolerance index and ion accumulations. Based on the above characteristics, G20, G5, G25, G18 and G16 pumpkin genotypes were considered as relatively tolerant against salinity compared to others.

Screening of tomato genotype for salinity tolerance at vegetative stage

Salinity stress is the major reasons affecting the optimum yield of vegetable crops considered as salt sensitive at early growth stage. Twenty-four crosses of tomato along with three commercial checks viz., BARI Hybrid Tomato-4, BARI Hybrid Tomato-8 and BARI Hybrid Tomato-10 were evaluated to determine their tolerance levels against three NaCl concentrations (0, 100 and 150 mM) in hydroponic system. Salinity was initiated at the fourth-true leaf stage of the seedling and after reached the final concentrations of NaCl, seedlings were grown for 10 days. The physiological characters such as leaf area, root and shoot length, fresh and dry weight of the plants parts, and the concentration of Na^+, K^+ and Ca^{++} were studied against the NaCl stress. Also the genotypes were evaluated for their salt tolerance by examining the visual appearance. Result showed that, the plants exposed to salt stress presented a significant decline in leaf area, root and shoot length, fresh and dry weight of the plants parts, and the reduction rate was lower in G5, G1, G7, G10, G14 and G16 tomato genotypes than others. Under salinity stress, these genotypes reduced more Na^+ ion and less K^+, Ca^{++}, K^+/Na^+ and Ca^{++}/Na^+ ratio as compared to other genotypes. However, in examining the visual appearance G5, G1, G7 and G10 genotypes were in scale classes 1 and 2. Based on the studying findings, G5, G1, G7, G10, G14 and G16 tomato genotypes can be selected as relatively tolerant against salinity stress.

Morpho-physiological evaluation of selected sesame genotypes against waterlogging stress

A study was conducted to examine the morpho-physiological response of selected sesame genotypes viz., G2, G3, G4, G5 and G7 (tolerant) and G1 & G6 (sensitive) under waterlogging stress. Plants were waterlogged at flowering stage (55 days after sowing) for 48 and 60 hours. Results showed that all the sesame genotypes respond to waterlogging in considerable different performance. The stress induced leaf chlorosis in all the genotypes but serious symptom occurred earlier in the sensitive genotypes (G1 and G6) and they did not survived in both waterlogging duration. Result showed that, Chlorophyll contents (Chlo a, Chlo b and Total Chlo) of leaves decreased in both waterlog duration. Carotenoid content also showed similar pattern of reduction. However, reduction of photosynthetic pigments were lower in G7, which was identical with G3 and G2 genotypes and the higher reduction was found in G4, followed by G5 sesame genotypes. In case of gas exchange parameters, a significant reduction were observed in net photosynthetic rate (Pn), stomatal conductance (Gs) and transpiration rate (Tr) at all the tolerant genotypes, but intracellular CO_2 concentration (Ci) increased at both waterlog conditions. The reduction rate of gas exchange parameters was less in the genotype G7 compared with other tolerant genotypes. Among the tolerant genotypes, G7 showed only 31, 45 and 60% reduction from the control plants in Pn, Gs and Tr, respectively, at 60 hour waterlog condition. On the basis of gas exchange and photosynthetic pigments G7, G3 and G2 sesame genotypes can be selected as tolerant against water logging stress.

Physiological and biochemical response of selected sesame genotype at vegetative stage to water logging stress

Sesame is extremely susceptible to waterlogging stress which results in the reduced growth and yield along with oxidative stress. A pot experiment was conducted with three selected sesame genotypes (G3 and G7 relatively tolerant and G1 sensitive genotype to waterlogging stress) under four duration of waterlogging stress (0, 48, 72 and 120 hours) to evaluate the physiological and biochemical responses of sesame against waterlogging stress. Treatment was imposed at 34 days after sowing (DAS) and water level was maintained about 3 cm above the soil surface of the pots. At 3 days after the removal of waterlogging (DARW) characteristics that were measured included, contents of hydrogen peroxide (H_2O_2), proline and Malondialdehyde (MDA), activities of Peroxidase (POD), Catalase (CAT), Superoxide Dismutase (SOD), Ascorbate (AsA). Reduced glutathione (GSH) and Oxidized glutathione (GSSG). Results showed the H_2O_2 and MDA increased in all the tested genotypes, while increasing rate was significantly lower in G7 than others. However, contents of proline and activities of ROS scavenger enzyme was higher in G7 than other genotypes. This results suggested that, G7 and G3 sesame genotypes showed a substantial tolerance to waterlogging stress by increasing organic osmoregulation content and activities of ROS scavenger enzymes.

Morphophysiological changes of selected grasspea genotypes under salinity strss

A pot experiment of two selected grasspea genotypes (BD-4774, and BD-5880) were conducted during *rabi* season of 2019-20 at the Pot house of Plant Physiology Division to study their i) performance of different growth parameters and germination in different salt levels and ii) physiological parameters as effected by different level of salinity. The experiment was conducted from November 13, 2019 to February 30, 2020 in pot and soil media. Two grasspea genotypes (BD-4774, and BD-5880) collected from Plant Genetics Resource Center (PGRC), BARI were used in the study. The experiment assessed the germination and physiological parameters of grasspea genotypes at different NaCl salinity levels. The NaCl concentrations used were 0 (control), 50 dS^{-1} and 10 dS^{-1}. The salt solution was prepared calculated amount of NaCl in distilled water which was used as treatment. The PH of treatment solution was maintained 6-7. Earthen pots were used in the experiment and arranged in a Completely Randomized Design (CRD) with three replications. Each pot was supplied of the respective treatment solution as per need. Seeds were sown on the pots and fertilized @ 10-10-12-6 kg ha^{-1} of N-P-K-S in the form of urea, triple super phosphate, muriate of potash and gypsum respectively (FRG 2018). Ten seeds were sown in each pot. The germination count was taken after 72 hours of sowing seeds. At flowering stage the physiological data and at ripening stage of the pods, the yield and yield attributes data were collected. Several biochemical components (Chlorophyll-a, Chlorophyll-b, Total chlorophyll) along with yield and yield attributes were revealed. The genotype BD-5880 shows the significant performance in producing higher emergence, days to maturity, no of pods/plant, 100 seed weight (g) and seed yield (t/ha). In case of root length (cm), shoot length (cm), shoot dry matter/plant (g), root dry matter/ plant (g), and leaf chlorophyll content (chlorophyll-a, chlorophyll-b and total chlorophyll) BD-4774 gave the higher content. So it might be concluded that considering some physiological and yield attributes, genotype BD-5880 is more saline tolerant between the genotypes.

Morphopsysiological and yield response of tomato as influenced by different plant growth regulators

A field experiment was carried out at Plant Physiology Research Field of Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh to assess the effect of plant growth regulators on tomato during winter season 2019-20. Different plant growth regulators available in market (PGR) viz., PGR_1 = Flora @ 20 ppm, PGR_2= Protozim @ 20 ppm, PGR_3=Vagimax and PGR_4= Miraculan@ 20 ppm and PGR0 = Control (No PGR) were used in the study. The experiment was laid out in Randomized Complete Block Design with three replications. Fertilizers were applied @ 80-30-40-14-1.0-0.5 kg ha^{-1} of N-P-K-S-Zn-B in the form of urea, tripple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid respectively (FRG 2018). Half urea, muriate of potash and full amount of all other fertilizers were applied as a basal dose during final land preparation. Remaining urea and muriate of potash was applied at two equal installment at 15 and 30 DAT. The cowdung@ 5 tha^{-1} was applied as organic fertilizer. Twenty four days old seedlings of BARI tomato 14 were transplanted at spacing of 60cm × 40cm in the experimental plot on November 24, 2019. Later the stock solution was diluted in distilled water to prepare the working solutions just before application. Spraying was performed early in the morning to avoid rapid drying of the spray solution, due to transpiration. Data were collected from ten randomly selected plants from each plot; viz., plant height (cm), number of fruits plant^{-1} , fruit length and diameter, average fruit weight (g) and yield/ha. The means were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance. The growth and yield contributing character were significantly differed due to different plant growth regulators. The maximum number of fruits plant (65) was recorded from (application of Flora @20 ppm) while the minimum number of fruits plant(25) was recorded from (no application of plant growth regulators. Plant growth regulators had significant influence on growth and yield of tomato and gave the highest yield PGR1 = Flora @ 20 ppm than other plant growth regulators. So, among the four plant growth regulators (PGR), application of Flora @20 ppm gave the best response for tomato production.

Evaluation of physiological parameters of garlic variety under salinity stress

An experiment was conducted to evaluate the responses of different garlic varieties towards salinity stress in a pot house of Plant Physiology Division, BARI, Gazipur during the period from November, 2019 to March, 2020. Five garlic varieties *viz.*BARI Rashun-1, BARI Rashun-2, BARI Rashun-3, BARI Rashun-4 and Natore (Chalanbeel) local were grownup subjecting to four salinity levels *viz.* 0, 4, 8 and 12 dS m^{-1}. The study was laid out in Randomized Complete Block (RCB) design with six replications and each pot was considered as one replication. Therefore, conveniently to carry out the treatment total 120 pots were arranged with placement of 30 pots in four replicate blocks and filled with 4:1 volume ratio of soil and well decomposed farm yard manure. Each pot contained approximately 12 kg of soil. Fertilizers @ 114-48-90-30-3.0-3.0 kg ha^{-1} of N-P- K-S-Zn-B were applied in the form of urea, triple super phosphate, muriate of potash, sulphur and zinc sulphate and boron respectively (FRG, 2018). The cloves were planted on 13 November, 2019. The salinization was started from 20 DAE by adding Nacl solution with an increment of 5, 10 & 15 dSm^{-1} for 4, 8 and 12 dSm^{-1} salinity level respectively in every 7-10 days intervals and continued up to reach a desire concentration level. In control treatment pond water was used. Salinity levels were maintained by monitoring with EC meter and adding salt solution when required up to maturity. Salinity effects were evaluated on the basis of physiological, biochemical, yield contributing and yield indices. Aggravated salinity stress caused significant variation in all measured parameters and showed more detrimental effect compared to control as well as lower salinity levels. Sodium (Na^+) and Potassium (K^+) ion content and their ratios (K^+/Na^+) in leaf tissue were significantly affected by salinity and genotypes showed significant variability. The variety BARI Rashun-4 possessed better ability to maintain stable osmotic potential maintaining the highest K^+/Na^+ ratio at 12 dSm^{-1} saline environments followed by BARI Rashun-3, which indicated the higher tolerance to salinity compared to others. The variety BARI Rashun-1 and BARI Rashun-4 showed the less reduction of chlorophyll pigments at 12 dSm^{-1} salinity than other varieties. The variety BARI Rashun-4 showed the higher activity of CAT, POD and lower lipid peroxidation at 12 dSm^{-1} saline environments compared to others. Total dry matter (TDM) production and yield contributing characters were less decreased in BARI Rashun-4 and BARI Rashun-3 at severe saline environments than others.

Morpho-physiological responses of the selected chilli genotypes in variable shading condition

A trial was conducted in Pot house of Plant Physiology Division of BARI during *rabi* (winter) season 2019-2020 to validate the shade loving Chilli genotypes. Previously selected four Chilli genotypes/varieties Co-640, Co-637, Co-639, BARI Morich-3 were grownup subjecting to three individual environments *viz.* open field condition (no shading), 50% shading at transplanting and at 30 days after transplanting (DAT) of seedling. The shading was ensured by bamboo's structure covering the top and lateral part using mosquito net.The measureable light reduction in 50% shading was measured by a SunfleckCeptometer (LP-80, Decagon Device). The experiment was carried out in RCB design with five replications. The shade loving Chilli genotype were evaluated basased on morpho-physiological, anatomical, yield contributing and yield parameter. The physiological parameters like net photosynthetic rate (µmol m^{-2} s^{-1}) and total conductance of CO_2 (mol m^{-2} S^{-1}) were investigated using Licoor-6800 a portable photosynthesis system. Results revealed that phenological trait like onset of flowering were delayed on an average 3 to 4 days than open sunny environment due to the shading in genotype Co-640 and Co-637. The genotypes Co-640 and Co-639 were the late (49 to 54 days) and early (39 to 43 days) respectively to perform the first flower under both shading and open field condition (non-shading). The genotype Co-637 showed the tallest stature under both shading environment while under open sunny environment it showed the shortest stature. The genotype Co-640 produced the maximum fruit length (8.60 cm) and weight of 5 fruits (30.5 g) and Co-637 produced the significant amount of fruit $plant^{-1}$ (70.0) at 50% shading condition that directly contributed in producing maximum fruit yield (439.60 g $plant^{-1}$) and (371.80 g $plant^{-1}$) respectively. The genotype Co-639 also showed the better response in producing fruit length (6.25 cm), fruit yield (260.4 g $plant^{-1}$) as well as physiological parameter at 50% shading condition. Shading effect caused reducing the rate of PAR absorption, photosynthesis and total CO_2 conductance irrespective of all genotypes. However, these parameters were less reduced in genotypes Co-640 and Co-639. Therefore, Chilli genotypes Co-640 and Co-637 were suitable for farming at reduced solar radiation (shading) environment due to production of significant yield. Irrespective of genotypes/varieties, two micro environments did not show a regular superiority or inferiority among the studied parameters.

Stolon development and tuber formation pattern of potato varieties at different planting dates

A field experiment was conducted in Plant Physiology Division research field of BARI during *rabi* (winter) season of 2019-2020 with three replications to study the effect of planting dates on varieties concerning stolon development and tuber formation of potato. Three potato varieties *viz.* BARI Alu-37, BARI Alu-79 and BARI Alu-81 were planted in three distinctive dates *viz.* November 21, December 01 and December 10 respectively. In three replications, treatments were laid down in split plot design allocating the planting dates and varieties in main plots and sub-plots respectively. The unit plot size was 2.4 m × 3.5 m. The seed tuber of each variety was planted by hand with spacing of 60 cm × 25 cm in furrows followed by earthing up. Importantly, for the management of root-knot disease of *Solanum tuberosum* with nematicide Furadan 5G @ 20 kg ha^{-1} was applied in furrows before earthing up. Fertilizers were applied as per the general recommendation of FRG (2018). Accordingly, the soil was fertilized @ 150-45-125-20 kg ha^{-1} N-P-K-S respectively in the form of urea, tripple super phosphate, muriate of potash and gypsum. The half urea and full amount of all others fertilizer were applied as a basal during final land preparation and remaining urea was applied at 30 days after planting (DAP) and earthing-up was done to prevent exposure of tubers to direct sun light and for promoting tuber bulking. Growth period, morphological index and change in yield, yield contributing index and their relationships with temperature were investigated. Results indicated that crop growth with different planting dates experienced different weather conditions, which lead to show variation in distinct growth duration, morphological, growth, yield and yield contributing index. Interaction of varieties and planting dates showed the significant variation in growth duration behavior. Planting dates induced temperature variability showed significant variation on plant height, number of stolon and leaf area $plant^{-1}$, dry matter production and tuber yield. Leaf area $plant^{-1}$ was higher in varieties BARI Alu-37 & BARI Alu-81 in November 21 planting followed by December 10 planting in BARI Alu-79. Differences in tuber yield were found among the three planting dates, potato planted on 21 November gave the highest tuber yield. Significantly decreased the total dry matter production in potato varieties with greatest suppression under December 10 planting. On the basis of growth parameters and tuber yield, the variety BARI Alu-81 and BARI Alu-37 can be selected as a late planting variety to tolerate higher temperature stress.

Integrated nutrient management for quality seed production of bush bean (*Phaseolus vulgaris* l.)

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season of 2018-19 and 2019-20 respectively, to study the effect of different integrated nutrient management package on quality seed production of bush bean. A total of five treatments *viz.*, T_1= 100% FRG (70-30-45-8-2-1.4Kgha^{-1} N-P-K-S-Zn-B) + CD @ 5 ton ha^{-1}, T_2=80% FRG + Vermicompost @ 3 ton ha^{-1}, T_3=100% FRG + *Rhizobium* Biofertilizer @ 50g kg^{-1} seed, T_4 =100% FRG + Biochar @3 ton ha^{-1} and T_5=80% FRG + Poultry manure @ 5 ton ha^{-1} during 2018-19 and next year (2019-20) included another treatment T_6 =80% FRG + Trico Compost @ 3 ton ha^{-1}. The morpho-physiological, yield and seed quality parameters of bush bean had the significant effect of treatments. Highest average seed yield of 1.72 tons ha^{-1} was recorded in T_4 treatment. The results indicated that the treatment T_4 also observed significantly higher on plant height (58.04 cm), SPAD value (53.20), NDVI value (0.83), number of branches plant^{-1} (7.71), shoot dry weight (15.93 g), number of pod per plant (21.89), pod weight/plant (19.88g), length of pod (13.79 cm), number of seeds/pod (5.41) and hundred seeds weight (27.45g). Seed quality parameter such as germination percentage (90.67%), moisture percentage (5.47%), seedling root length (9.02 cm), seedling shoot length (21.73cm), seedling dry weight (185.6 mg), seedling vigour index I (2788) and seedling vigour index II (16824) were recorded from T_4 and T_6 treatment. It can be concluded that treatment T_4 and T_6 showed high quality seed production and synergistic effects on growth and yield of bush bean.

Hybrid seed production of BARI Hybrid Mistikumra-1

The field experiment was carried out during 2019-20 *rabi* at Seed Technology Division, BARI, Gazipur-1701, to increase the quality hybrid seeds stock of BARI hybrid Mistikumra-1 for demonstration and distribution. The seed of parental lines of BARI hybrid mistikumra-1 was obtained from the Olericulture Division, Horticulture Research Center, BARI, Gazipur. The seedlings were raised in controlled conditions and 30 days old seedlings were transplanted maintain one seedling per hill at the spacing of 3.0 m x 1m. Planting ratio was 3:1 was applied i.e. 3 female and 1 male. Male plant was sown 10 days after females for synchronization of flowering. Finally, 2.10 kg quality hybrid mistikumra seed was harvested and kept safe store for distribution.

Growth and quality seed production of onion influenceed by plant growth regulator

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season of 2019-20, to study the effect of different concentrations and stages of application of growth regulators on growth, yield and quality seed production of onion and to find out the suitable growth regulators or its concentrations for better growth, yield and quality seed production of onion. The experiment was laid out in RCBD with four treatments combinations *viz.* T_1= Control (0.0 ppm GA_3), T_2= 100.0 ppm GA_3, T_3= 200.0 ppm GA_3, and T_4= 300.0 ppmGA_3. The bulbs were soaked in treatment-wise concentrations of GA_3 in tray for 48 hours, then soked seeds were sown directly in experimental filed plots. The earliness of bolting and bolting period was found from treated onion bulbs with

GA_3 at 300 ppm compared to the control. The highest significant differences of seed yield, weight of 100 seeds and seed germination % was found from GA_3 at 300 ppm compared to the control. It was concluded that treatment T_4 (300.0 ppm GA_3) showed high quality seed production and synergistic effects on growth and yield of onion seed.

Assessment of seed quality of brinjal through accelerated aging method

Seedling growth depends on consequence of seed deterioration. An experiment was conducted to evaluate the effect of duration of seed aging on brinjal seeds quality characteristics on brinjal varieties. The experiment was conducted in completely randomized design with 3 replications. Seeds were subjected to accelerated aging treatment for, 24, 48 and 72 hours at 45 ±1 C° and 100% relative humidity. These artificially aged seeds were compared to control (unaged seeds) for evaluation of seed quality parameters. Accelerated aging of brinjal seeds up to three days had significant effect on germination percentage. The accelerated ageing caused in addition of reducing germination percentage, they caused reduction in seedling length, seed vigor index, germination speed index, and shoot, root fresh and dry weight. Finally, the results revealed that accelerated aging caused depression of brinjal seeds viability through the above parameters.

Effect of sulphur fertilizer application on seed yield and seed quality of rapeseed

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season of 2019-20 to investigate the role of sulphur on seed quality of rapeseed. The experiment was laid out in RCBD with 5 treatment of sulphur fertilizer doses *viz*., T_1=0 Kg S/ha, T_2=10 Kg S/h, T_3=15 Kg S/ha, T_4= 20 Kg S/ha and T_5= 25 Kg S/ha. Mustard variety was BARI Sarisa-14. The results indicated that the application of 20 kg S/ha (T_4) noticed significantly the highest plant height (86.46 cm), number of branches /plant (4.80), number of pods/plant (51.26), number of seed/pod (31.80) and seed yield (1.207 t/ha) was recorded in 20 kg S/ha (T_4) and better seed quality parameter such as oil content (43.41%) and seed protein (21.32%) were also noticed from in 20 kg S/ha (T_4). So the treatment of 20 kg S/ha (T_4) was found suitable for higher seed yield and better quality of Mustard crop.

Effect of lateral vines removal on seed yield and quality of bottle gourd

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season of 2019-20 to investigate the removal of lateral vines for quality seed production of bottle gourd. The seed yield and quality parameters like number of fruits/plant, length of fruits (cm), diameter of fruits (cm), individual fruit weight (kg), fruit yield (t/ha), seed yield (t/ha), 100 seed weight (g), germination percentage, seedling dry weight and vigor index were influenced significantly due to removal of lateral vines on seed yield and quality of bottle gourd. In bottle gourd, the maximum number of fruits/plant (12.00 cm), length of fruits (59.93 cm), diameter of fruits (51.80 cm), individual fruit weight (7.527 kg), fruit yield (67.901 t/ha) and seed yield (1.260 t/ha) were observed in the treatment (T_4) removal of lateral vines up to 1.5 m. Among the treatments, (T_4) removal of lateral vines up to 1.5 m showed significantly better seed quality parameters such as 100 seed weight (28.31 g), germination percentage (100.00 %), seedling vigor index (11503) and seedling dry weight (115.03 mg).

Effect of plant growth regulators on seed yield and quality of soybean at different time of application

The experiment was carried out at the research field and laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season of 2019-20 to study the effect of plant growth regulator (GA_3) on seed yield and quality of Soybean at different stages of application. The factorial experiment was laid out in RCBD with 12 treatment combination of four different plant growth regulators *viz*., H_0 = Control (water), H_1= GA_3 (50 ppm), H_2= GA_3 (100 ppm), H_3= GA_3 (150 ppm) and three different time of application i.e. S_1= Vegetative stage, S_2= Flower initiation stage, S_3 = Pod formation stage. Soybean variety was BARI Soybean-6. The results indicated that the application of growth regulators GA_3 100 ppm (H_2) noticed significantly higher plant height (76.63 cm), number of seeds per pod (2.80) and seed yield (2.79 t/ha). Better seed quality parameter such as 100- seed weight (14.493 g), germination percentage (85.33 %) and vigour index (2780.9) were also noticed from GA_3 100 ppm (H_2). Among the different time of application, pod formation stage (S_3) recorded significantly higher number of pods per plant (111.28) and seed yield (2.80 t/ha) along with seed quality parameters *viz*., 100- seed weight (14.986 g), germination (84.00 %), and seedling vigour index (2722.4). So the treatment combination of GA_3 100 ppm at pod formation stage (H_2S_3) was found suitable for seed yield and quality of soybean crop.

Effect of milk and hydro-priming on seed quality of bitter gourd (*Momordica charantia* L.)

To meet the demand for an appropriate soaking duration and priming type, there is a need to embrace cheap, fast, natural, accessible, and adaptable physiological techniques as soaking of seeds in water and fresh cow milk. Fresh cow milk contains hormones that relieve seeds from photo, thermo, physiological and mechanical dormancy. In this regard this study was conducted to assess the effect of hydration and fresh cow milk on different seed quality attributes like germination percentage, mean germination time, the uncertainty of germination process, and synchrony of germination process of bitter gourd seeds. The study involved two factors, namely hydropriming and different concentrations of fresh cow milk (*viz*. 60%, 80% and 100%), and the other factor was seed soaking duration with 4 levels (i. e., 0, 12, 18 and 24 hours). The experiment was conducted in a Complete Randomized Design (CRD) with three replicates. Results revealed that the percent germination value of seeds soaked in all concentrations of fresh cow milk was better than hydropriming. A significant germination percentage value of 96% and 93% were recorded for seeds treated for 18 hours in 80% and 100% concentrations of fresh cow milk, respectively. Maximum uncertainty of the germination process and minimum synchrony of germination the process was recorded in the untreated seed.

Impact of foliar boron sprays on seed yield and seed quality of capsicum

An experiment was conducted under pot culture and laboratory of seed technology division, BARI, Gazipur during *rabi* season 2019 to find out the effect of foliar application of boron on plant growth, seed yield and quality of capsicum. The doses of boron were B_1 (control), B_2 (150 ppm), B_3 (200 ppm), B_4 (250 ppm), B_5 (300 ppm) and B_6 (350 ppm). Boron was applied as Boric acid (17.5% B) according to treatments at pre-flowering and flowering stage in capsicum plant. Maximum plant height (47.33cm), primary branches/plant (4), fruits/plant (4.33), seeds/fruit (115), seed yield/plant (498.33) were found when plants were supposed to foliar feeding of boron @ 250ppm. Better seed quality parameters were also found in the treatment T_4 in case of germination (79%), dry weight of seedlings (0.0953g) and vigor index of seedlings (7.523).

Effect of fruit size and seed position on seed quality of bottle gourd

An experiment was conducted in the laboratory of Seed Technology Division, BARI, Gazipur during *rabi* season 2019 to find out the effect of fruit size and seed position on seed quality of bottle gourd. Seeds were collected from three parts viz. proximal, middle and distal portion of large, medium and small size fruit. Maximum amount of seeds were collected from middle portion of large size fruit that showed maximum hundred seed weight (26.267g), germination (99%), dry weight of 5 seedlings (0.5688g), higher germination speed, root length (7.845cm) and vigor index I (55.25) than the other portion of fruit.

Effect of plant spacing and fertilizer dose on seed yield and quality of onion

A field experiment was conducted at the research farm of Regional Agricultural Research Station (RARS), BARI, Cumilla, Bangladesh during 2019-2020 to identify a suitable plant spacing along with fertilizer dose for higher seed yield with better seed quality of onion. Three plant spacing *viz*., 30 cm × 20 cm (S_1), 25 cm X 20 cm (S_2) and 20 cm × 20 cm (S_3) were assigned in main plots and four fertilizer doses *viz*., BARC fertilizer recommendation (FRG 2018; F_1), IPNS based fertilizer dose (F_2), Soil test based fertilizer (F_3) and Farmer's practice (F_4) were assigned in sub-plots. Onion variety was BARI Piaj-6. Considering seed yield, seed germination and vigor index of onion, plant spacing 20 cm × 20 cm along with IPNS based fertilizer dose showed better performance compared to any other treatment combination.

18 VERTEBRATE PEST

Evaluation of some plant oils as repellent against rodents

The experiment was conducted in outdoor rat enclosure at vertebrate pest division in BARI, Joydebpur, Gazipur during 2019-20 to evaluate three plant oil i.e. eucalyptus, neem and karanja as rodent repellant. Three outdoor rodent enclosures, were considered as three observations were used for each plan oil. A twig of cotton was put in a metallic food cup that was placed at one corner of enclosure. One drop of plant oil was provided on the cotton twig which was considered as repellent odor source. Four more food cups were placed at 1 cm, 50 cm, 1 m and 6 m distances from the odor source. Wheat grain was used as rat bait. Rodent repellency of specific plant oil at several distances was tested in each enclosure in a multi-choice situation.

All plant oils showed the similar repellence against rat feeding where those can repel rat up to 3 days from their food. Rat consumed significantly lower amount of food from within 1m distance (0-2.76 g/rat/day) of oil source compared to 6m distance (5.67-12.08 g/rat/day). At up to 1m distance of eucalyptus oil source, rat consumed 1.29-2.24 g food per day where as it was 1.23-1.62 g for neem oil and 1.4-2.76g for karanja oil.

Evaluation of some indigenous methods for controlling rodent in Bangladesh

The effectiveness of some indigenous techniques for repelling rodents was evaluated in the wheat field and road & drain side of Bangladesh Agricultural Research Institute Joydebpur, Gazipur during January 2020 to May 2020. Four indigenous techniques viz. kerosene mixed cow dung, engine oil mixed water, molasses mixed cotton and molasses mixed cement were evaluated for repelling rodents from crop field. There was an untreated control where no control measure was used. Only active burrows were used for this experiment. Burrows having clear symptom of rat inside and fresh soil in the opening were considered as active burrows. In wheat and pulse crop, about ten active burrows were used for each treatment on the basis of burrow availability. Treatments were replicate thrice. Before applying treatment all the active burrows were identified properly. Foot tracts activity were taken for two nights for both pre and post treatment operation.

The highest rodent repelling success was achieved in case of using kerosene mixed cow dung (74.12% success) that was statistically similar with engine oil mixed water (71.53% success). Only 21.80% success was found using molasses mixed cotton that was similar with molasses mixed cement (18.91% success).

Development of suitable rodent control techniques in floating agricultural system

A study was conducted at RARS, Rahmatpur, Barisal to evaluate the different rat control techniques against rodents in floating bed. Four treatment were use in floating agriculture for managing rat in floating bed *viz*., Live trap, kill trap, Net barrier around the bed and untreated control. Bait materials were used for trapping rats and these were Sweet goard, bread, potato, coconut, dry fish etc. Each type of bait was used for both types of traps set at a time. The experiment was conducted for 224 trap nights throughout the cropping season i.e., 112 trap nights for live trap and 112 trap nights for kill trap. When 1 trap was set for 1 night, it was considered as a 1 trap night. Equal numbers of trap nights were used for each type of trap. The traps were set two side of floating bed. The traps were set at dusk and collected next early morning. Traps were reset for the following nights, and trapped rodents collected and counted. Capture of rat species was the measure of trap success.The specimens so collected were brought to laboratory for identification. Highest (91.99%) reduction of rat population was recorded in 'polythene barrier' treated bed and lowest (0.03%) in 'control' treated bed. Three species of small mammals were found in floating bed. These are *Rattusrattua* (77.77%), *Bandicotabengalensis* (17.77%) and *Bandicotaindica* (4.4%).

Diets of barn owl (*Tyto alba*) and spotted Owlet (*Athene brama*) at Gazipur and Rajshahi district of Bangladesh

The diet of the Barn Owl Tyto *alba* and the Spotted Owlet Athenebrama were studied in the habitat of Gazipur and Rajshahi district, Bangladesh, during January 2019 to July 2020. Regurgitated pellets of these two owl species were analysed to understand their dietary composition. Pellets were collected from BARI research field, Gazipur and Rajshahi. A total of 20 pellets of Barn Owl *Tyto alba* and 12 pellets of spotted owlet *Athene brama* were collected from this roosting site. Regurgitated pellets found at all the sites were collected in polythene bags and brought to the laboratory. In the laboratory, pellets were kept at 60^0C in a hot air oven for 24hr to kill the associated insects and any other infectious agent. These pellets were then used for analysis. All the pellets were first weighed on electronic balance and then their morphometric measurements, i.e., length (mm), breadth (mm) and thickness (mm) were recorded. To record the diet composition of the Spotted Owlet and Barn owl, each pellet was first soaked in 8% sodium hydroxide solution for about four hours.This solution assisted in easy separation of the osseous remains (skulls and other bones) and chitinous contents (undigested insect remains) from other contents like hair, debris etc. The contents were then sieved to separate all the prey remains from the dust and soil particles. To completely separate the prey remains from these unwanted components, a number of washings were given. Then the prey remains were put on filter paper and dried in an oven for 24hr at 60^0C. After complete drying, the skulls, bones, feathers, beaks and insect remains were separated out for identification of prey items The diet of the Barn Owl mainly comprised small mammals (75.07%) include rat mice, shrew etc. and insect while the diet of the Spotted Owlet comprised mostly insects (57.7%) and Mus spp(21.61%). The Barn Owl and spotted owlet consumed more than one prey per day and chiefly foraged in agricultural crop fields and consumed both small mammals and insects of agricultural importance under cropping ecosystems.

Comparative efficacy of different traps (live, kill and gopher) for controlling rodents

Comparative efficacy of different traps was evaluated at BARI central research fields during *rabi* season, 2019-20 to find out the most suitable trap for capturing rats. Three types of traps such as live trap, kill trap, and Gopher trap were used at different wheat and barley fields for this study. The experiment was conducted in two wheat and two barley fields for seven trap nights. In each wheat field 5 live traps, 5 kill traps, and 5 Gopher traps were set. Each active burrow was treated with one trap per night. Therefore, total 560 trap nights were used for this study. So, each type of trap was used for 140 trap nights. Live traps and kill traps were set near the burrow opening while Gopher traps were set inside the burrow opening. All traps were set in every evening and the data were recorded in the following morning. From this experiment, it was revealed that success rate of live traps was higher than the kill traps and Gopher traps. Average success rate of live trap was 44.63% whereas success rate of kill/snap trap was 37.5% and it was only 28.57% in in case of gopher trap.

Effectiveness of seed treatment with anthraquinone and chlorpyrifos for reducing bird damage in wheat

The experiment was conducted at the bird aviary of Vertebrate Pest Division, BARI, Gazipur during *rabi* season to evaluate four concentrations (25%, 50%, 75%, and 100% of recommended rate) of two chemicals named Anthraquinone and Chlorpyrifos as repellents against blue rock pigeon. It was observed that consumption of treated seeds was significantly lower than the untreated seeds. Average consumption of Chlorpyrifos treated wheat seeds was 11.70 (± 0.76) g and untreated wheat seeds was 25.24 (± 0.84) g. The lower consumption {8.51 (±0.25) g and 8.47 (± 0.22) g} was obtained from the treated wheat seed with 75% and 100% recommended rate of Chlorpyrifos respectively. Consequently, around 50% repellency was found from both of the treatments. On the other hand, average consumption of Anthraquinone treated wheat seeds was 4.25 (± 0.73) g and untreated wheat seeds was 31.10 (±0.99) g. The lower consumption was {1.52 (± 0.33) g and 1.47 (±0.43) g} obtained from the treated wheat seeds with 75% and 100% Anthraquinone. Accordingly, both treatments gave more than 80% repellency against the test birds.

Efficacy of Commando, Zill phosphide and Zero phosphide for controlling rats

The experiment was conducted at the Vertebrate Pest Division, BARI, Gazipur to study the effectiveness of 'Zero phosphide, Commando and Zill phosphide as rodenticide. All the rodenticideswere acute poison (Zinc phosphide) supplied from company. Zero phosphide, Commando and Zill phosphide bait contain 2% Zinc phosphide (80% a.i) as an active ingredient. The choice feeding tests were conducted in the laboratory using 20 (10 males and 10 female) acclimatized adult rats in each sample. Six hours starved rats were exposed individually to poison bait in a food cup for 24 hours. Two food cups were provided to each animal, one cup containing 10g of poison bait and the other containing 20g of plain wheat grains for each sample. In "choice" feeding test all the rodenticide showed more than 90% mortality of Bandicoot rat was recorded. The average poison bait consumption was 0.81, 1.17 and 1.83 g/rat/day in Zero phosphide, Commando and Zill phosphide treated bait, respectively.

19 POSTHARVEST TECHNOLOGY

Standardization of jackfruit jam using different fruit juices

The objective of the present study was to standardize jackfruit jam using different fruit juice to minimize the strong flavor of jackfruit. Accordingly, six jackfruit jam sample was prepared using different concentration (5% and 10%) of mango, lemon and malta juice. The quality parameters such as moisture content (%), water activity, acidity (%), TSS (ºBrix), ascorbic acid (mg/100g), total carotenoids (mg/100g), reducing sugar (%), total sugar (%), color and sensory properties were evaluated. Results revealed that moisture content was ranged from 22.36 to 42.47% in 5% fruit juices and 20.27 to 39.71%, in 10% fruit juices water activity ranged between 0.770 to 0.865 and 0.755 to 0.868, total acidity varied within 0.103 to 0.256% and 0.117 to 0.257%, TSS was ranged between 65.50 to 67.65ºBrix and 64.80 to 67.22ºBrix, ascorbic acid between 4.69 to 5.88 mg/100g and 2.36 to 4.04 mg/100g and total carotenoids between 9.37 to 14.26 mg/100g and 6.44 to 10.88 mg/100g after 60 days and 180 days of storage, respectively. It was observed that all the jackfruit jam contained good nutritional quality. The results for color attributes revealed that the studied jackfruit jam was moderately light, whose values ranged from 38.88 to 43.97 and 49.07 to 67.46; the a* values were ranged from -6.58 to -4.83 and -11.37 to -7.84 and the b* (blue/yellowness) values were found to range between 11.05 to 13.46, and 19.84 to 36.15 after 60 days and 180 days of storage, respectively. The results of nutritional quality and consumer perception reports revealed that jackfruit jam prepared using 10% lemon and 10% mango juice performed best and acceptable nutritional quality with sensory properties during storage period.

Design and development of low cost small scale vacuum fryer with de-oiling machine

The study was conducted to design and development of a low cost small scale vacuum fryer with de-oiling machine for fruits and vegetables chips with a view to prepare quality fried chips product which will be safe for human health. The fabricated vacuum frying machine comprised three basic parts such as frying chamber, condenser and vacuum pump. Frying chamber belongs frying basket (304 × 304) mm and heating coil (4 kw, 220V, AC). Temperature sensor are connected with the thermocouple system to control the frying temperature. Condenser is added to exchange heat of stem from produced frying chips. Two stage oil type vacuum pump (1 Hp) is used to create low pressure in the frying chamber during chips frying. De-oiling machine consists of perforated chips basket and control panel fabricated with stainless steel. To release excess oil from the fried chips, 1.5 Hp motor is used for rotating the fried chips basket at 1400 rpm. To prepare and evaluate the quality fried chips sweet potato and jackfruit were used with the vacuum fryer with de-oiling machine. It was observed that 700 – 800 g processed raw samples is used for one batch frying and 500 - 600 g fried chips is de-oiled for one batch. The machine is affordable (1,40,000 – 1,60,000 Tk.) especially for SME (small and medium entrepreneurs) level to produce quality fruits and vegetables chips products.

Optimization of processing parameters for fresh-cut tender jackfruit

Jackfruit (Artocarpusheterophyllus L.) in its tender form is consumed as a vegetable and popular for its flavour, colour and meat like texture. In south Asian countries the tender jackfruit has a huge market potential. To make available the tender jackfruit in the market, the present study was conducted to optimize the fresh-cut processing treatments of tender jackfruit to extend its shelf life and edibility. For this, fresh-cut jackfruit slices were pretreated by dipping into 0.03% KMS and 1% $CaCl_2$ solution for 30 min followed by blanching in boiling water for 2 min. The blanched jackfruit slices were instantly cooled and surface dried and then wrapped with cling paper. Fresh-cut jackfruit stored at different storage temperature (3, 6, 9, 12, 15 and 22^oC) maintaining the relative humidity of 85±5%. Different physicochemical and antioxidant properties were evaluated and also the samples were visually observed throughout the storage period. Results revealed that samples at 22^oC became spoiled at 2nd days of storage and samples stored at 15^oC spoiled at 4th days of storage. Those sample were good and had edibility showed excellent nutritional quality especially in the retention of ascorbic acid, beta-carotene, total phenolics and antioxidant activity. Results of this study concluded that the prepared fresh-cut jackfruit storage at 3^o and 6^oC is suitable to retain the nutritional quality and edibility upto 3 days.

Development of vacuum fried sweet potato chips

The experiment was conducted for development of sweet potato chips using vacuum fryer. BARI SWEET POTATO-7 variety was selected for the study where three different frying temperature (100, 110, 120^oC) and three different frying time (8, 10, 12 min) was considered as per few trial experiment. To identify the suitable pre-treatment for raw sweet potato chips, without blanching and without sugar (Treatment-B) coating performed most suitable treatment considering good appearance, texture and crispiness properties. The result showed that among the treatments, most of the panelists preferred vacuum fried sweet potato chips product fried at 110^oC frying temperature with 12-minute frying time in response of the overall sensory acceptability score (7.05±0.05) as physic-chemical properties after 60 days of storage.

Baseline survey on existing hazardous agents in selected fruits in supply chain at selected areas of Bangladesh

A survey was conducted in four districts namely Tangail, Chapainawabganj, Bogura& Gazipur. A total of 30 samples having 120 samples from the above-mentioned districts were randomly selected by the questionnaire. Data analysis from the collected data, the selected farmers were grouped into four categories based on the age distribution. Most of the farmers belonged to the age group as following in Tangail 41-60 (48.15%) years, in Chapainawabganj 41-60 (46.43%) years, in Bogura 21-40 (57.14%) years. According to educational level, illiterate, primary, secondary and higher secondary levels of education were recorded. Literacy rate was found higher in Tangail (36.33%) compared to other selected districts. However, most of the farmers did not receive any training on fruit pest management although some of them were engaged with various NATP program. It was claimed that different types of insect-pest and diseases attacked the food crops at different growth stages, which caused severe loss of yield in the studied areas. Hence, almost all of the fruit growers used synthetic pesticides for protecting their crops from insects and pests. Among the farmers, nobody followed IPM approach in his pest management program. Generally, farmers of the study areas applied pesticides with higher dosages and frequencies (10-15 times) per season than the recommendation level. In case of awareness for maintaining hygienic condition, Bogura and Gazipur district peoples do not use hand gloves during harvesting of their produce. Most of the people of the study area are not familiar regarding cooling chain management of produce during long distance transportation, which cause losses of produce quality. Almost all the case they are unknown of the physical, chemical, microbial and cross contamination.

Effect of different sanitizer on postharvest quality of tomato

The present study was conducted to evaluate the efficacy of selected sanitizers such as, acetic acid (0.5%), trisodium phosphate (1%) and calcinated calcium (0.01%) on postharvest quality and shelf life of fresh tomato fruits. Green to tannish yellow colored tomato was collected and dipped into the selected sanitizer solution and stored at ambient condition (26±2^oC & 80±5% RH). Different physicochemical properties including color, weight loss (%), moisture content (%), total acidity (%), total soluble solids (%), total carotenoids (mg/100g), lycopene (mg/100g), ascorbic acid (mg/100g), total phenolic content (mg GAE/100g) were evaluated in addition with the microbial load (cfu/g). Results indicated that most of the studied parameters were not significantly differed during the storage period. Although, ascorbic acid (%) and total phenolic content decreased in all treatments, however, retained considerable amounts of these compounds. On the other hand, microbial study revealed that control sample contained the highest number of viable bacteria (cfu/g) while 0.01% calcinated calcium treated sample had reduced number throughout the storage period. From this study, it can be concluded that tomato can be stored up to 12 days with considerable retention of nutrients. However, in terms of microbial load, calcinated calcium treated sample is acceptable upto 8 days of storage.

Determination of hazardous agents (microbial load & heavy metal) in different source of supply chain at selected locations in Bangladesh

This experiment was conducted to find out hazardous agents such as microbial load and heavy metals in different source of water sample from Cumilla and Bogura districts of Bangladesh. Different Source such as canal, river, tube-well, submersible and market water, those are used during vegetable wash. All samples were analyzed to detect the presence of different microbial agents such as Salmonella spp., Shigella, Escherichia coli (E. coli), Staphylococcus aureus, and Listeria monocytogenes. Results showed that water samples collected from Cumilla and Bogura districts contained a significant amounts of microorganisms. On the other hand, different concentration of heavy metals like Pb, Cd, As, Cr, Ni, Co, Fe were also detected in different water sources (canal water, river water, tube well water & 2 different market water) from Cumilla and Bogura districts.

Determination of formaldehyde in selected fruits and vegetables

The experiment was conducted to detect naturally produced formaldehyde in fruits and vegetables based on spectrometric analysis in the laboratory of Postharvest Technology Division, BARI, Gazipur SGS Bangladesh Limited Dhaka during 2019-2020. Some fruits and vegetables pointed gourde, snake gourde (chichinga), sweet potato, okra, lemon, green Banana (kacha kola),green jackfruit (kachakathal),green mango (kachaaam), mandarin bitter gourde, brinjal, green chili pepper (kachamorich) and onion were collected from local market and analyzed to estimate the amount of formaldehyde which was produced naturally. Results revealed that naturally occurring formaldehyde was not detected in bitter gourde, brinjal, green chili pepper (kachamorich) and onion. Formaldehyde naturally produced in pointed gourde 3.07ppm (avg), snake gourde (chichinga) 3.10ppm (avg), sweet potato 7.57ppm (avg), okra 3.46ppm (avg), lemon 5.52ppm (avg), green banana (kacha kola) 6.07ppm (avg),green mango (KachaAam) 5.52ppm (avg) and mandarin 12.02ppm (avg). From SGS Bangladesh Limited Dhaka their result showed that, okra, bitter gourde, lemon, green jackfruit (kachakathal), green mango (kachaaam) and mandarin were not detected formaldehyde content.

Comparison of nutrient composition, antioxidant activity and common phytochemicals of selected BARI mango varieties

The present study sought to explore the nutritional composition, minerals, bioactive phytochemicals and antioxidant activity of the selected BARI mango varieties. The total phenolic (TPH), vitamin C, total carotene, ß-carotene content and antioxidant activity of the mangos were determined by 1,1- diphenyl-2picryl hydrazyl (DPPH) scavenging, and reducing power (RP) assays. Phenolic compounds were assessed using high-performance liquid chromatography coupled with a photodiode array detector and auto sampler. Results revealed that edible portion of the fruit ranged from 144.40 g to 306.10 g and non-edible portion from 63.20 g to 110.90 g per fruit. Moisture content of the BARI mango-2, BARI mango-3 and BARI mango-11 recorded as 83.23%, 77.50% and 83.66% respectively. The highest total soluble solid (TSS) (23.00%), total sugar (13.46%), 2, 2-diphenyl-1-picrylhydrazil (DPPH) (98.18%), Inhibitory concentration (IC_{50}) (27.90 µg/mL) and Total antioxidant capacity (TAC) (186.42 mg/100 g) was recorded in BARI mango-3. BARI mango-11 provides major constituents of DPPH (97.75 %), Reducing power capacity (RPC) (18.70 µg/mL) and Nitric oxide free radical scavenging activity (NO) (70.20 µg/mL) whereas the commercial cultivar Langra donates TPH (210.90 mg GAE/g), Total flavonoid (TF) (1.38 QE/g), Total carotenoid (TC) (4.21 mg/100 g), ß-carotene (314.00 µg/100 g), TAC (189.22 mg/100 g), and Metal chelating capacity (MCC) (177.80 %). Among six different phenolic acids identified and quantified, all the acids were leading acids in Langra cultivar compared to BARI mango-2, BARI mango-3 and BARI mango-11. Vanillic acids was not detected in BARI mango-2 and BARI mango-3. Moreover, different phytochemicals and antioxidant assays such as TAC, reducing power assay (RPA), DPPH (2,2-diphenyl-1-picrylhydrazil), Ferric reducing antioxidant power (FRAP), MCC and NO free radical scavenging activity revealed that all the varieties extract had a great potential to fight free radical chain reactions and for usage in therapeutic applications. In fact, all the BARI mango varieties and commercial cultivar are a great potential source of nutrients, minerals, bioactive phytochemicals and antioxidant compounds.

Development and quality evaluation of ball (LADDU) from pineapple pomace

Pineapple pomace was utilized by preparing a small ball (laddus) using different treatments and complete randomized design (CRD) with three replications. The developed 'Laddus' were stored in pet boxes for two months to observe the physico-chemical changes, sensory attributes and microbiological activities. The highest TSS, energy, crude fiber, crude protein, vitamin-C, ß-carotene, total and reducing sugar was recorded in our developed laddus than the traditional laddu. A decreasing trend of water activity was found in our developed laddus than the market laddu. The high amount of water activity presence in the market laddu may be contributed to grow black mold. The storage studies confirmed that the marketability of our developed laddu T_1 (pineapple pomace 500 g+ coconut meat 500 g+ gaggery 1.00 kg+ Ghee 2 table spoon+ cardamom seed 20 pcs) could be extended one month more whereas the market laddu could be up to 9 days. T_1 also found to be the best by the panelist of the sensory evaluation.

Standardization of processing parameters for sapota jam

Jam is prepared from fruit pulp by boiling with sufficient quantity of sugar to a moderately thick consistency. There are different types of fruit jams like strawberry jam, mango jam, pineapple jam, apple jam and mixed fruit jam. Hence an attempt was made to find out the possibilities to prepare the sapota jam mixing with carrot. Sapota and carrot pulp was blended in the ratios of 100:0, 75:25 and 50:50 respectively to prepare blended jams. The treatment of T_2, 75% sapota pulp and 25% carrot pulp, showed performed better considering the physic-chemical properties. According to the sensory results, the highest score for colour (8.00), flavor (7.10), texture (7.20), mouth fell (7.40), and overall acceptability (7.50) was judged in the treatment T_2.

Processing and preservation of ready to cook jackfruit

The current study was carried out with the objective of developing ready to cook (RTC) jackfruit and evaluate their nutritional and sensory quality. In this study, green tender jack fruits were harvested after 60 to 70 days after synthesis (DAS). Then the fruits were washed, peeled and sliced. Then the slices were treated with different treatments viz. control, dipping into 0.5% salt solution, 0.2% citric acid solution, 1000 ppm potassium metabisulfite (KMS), KMS 1000 ppm+ 0.5% salt, KMS 1000 ppm+ 0.2% citric acid, 0.5% salt + 0.2% citric acid and 1000 ppm KMS+ 0.2% citric acid+ 0.5% salt. Then the treated sliced was steam blanched for 6 min. The blanched sliced were mixed with roasted beef spices. Then the roasted slices were dried at 50°C, 60°C and 70°C temperature. Results revealed that RTC dried at 50°C, 60°C and 70°C temperature took 72 hrs, 48 hrs and 36 hrs respectively. The physico-chemical characteristics like vitamin-C, ß-carotene and energy were retained more by the 60°C temperature. Color, flavor, texture, astringency, bitterness, taste and appearance were evaluated by sensory panel using a 9-point hedonic scale. The highest score was obtained by the RTC dried at 60°C. The moisture content was found to be 5.70 %. Cost of the product was found to be Tk. 25/kg.

Effect of starch coating on quality and marketable life of fresh cut guava

Guava (Psidiumguajava L) is a major fruit having high nutritional value. Bangladesh is one of the leading producers of guava now. The fruits go to loss in postharvest due to its proper processing technology and also people does not familiar with its consumption except fresh one. Hence, adoption of minimal processing technique will be a possible solution to overcome these problems. But the oxidative stress imparted in fruits and vegetables during cutting and slicing operations remaining as a hurdle in marketing of minimally processed fruits and vegetables. The prolonging marketable life of the minimally processed fruits using different coating materials is still now meager. Therefore, in present study was taken to prolong the marketable life of the fresh cut guava using different natural and commercial coating. The natural coating was extracted from the potato and cassava and then it was applied to the fresh cut guava. After coating the fresh cut guava was packed into PET boxes and kept in refrigerator at 5±1°C. The quality of the minimally processed fresh cut guava was evaluated at 1 days of interval. The maximum marketable life was recorded in fresh cut guava treated with 2.0% cassava starch with normal H_2O (T_2). The highest score was gained in treatment T_2 by the panelist of the sensory evaluators.

Kinetics of drying and assessment of the physico-chemical properties of osmo-dehydrated plum

The experiment was conducted to optimize the drying kinetics and quantify the various physico-chemical properties of the osmo-dehydrated product from plum during storage in an ambient condition. There were six treatments with the combinations of three different concentrations and two peeling conditions. The different parameters of drying kinetics, rehydration properties, water activity, product color, texture, sugar, total phenol and overall acceptance were analyzed in this experiment. The faster drying rate was seen in the combination of 5 percent NaCl with peel plum and the highest reconstitution was found in 50 percent sucrose without peel plum. The lower values of water activity and texture indicated that the good quality of osmo-dehydrated plum. However, the intensity of color parameters gives the good results of osmo-dehydrated products from plum using 50 percentsucrose without peel plum. The highest concentration of sucrose gave the more sugar content and less total phenol content in the products. On the other hand, the osmo-dehydrated products from plum using 50 percentsucrose without peel plum scored highest overall acceptance (8.0 e.g. like very much) followed by the product of 50 percent sucrose with peel plum considering sensory evaluation analysis. Finally, it was concluded that the osmo-dehydrated products from plum in 50 percent sucrose without peel plum performed better considering the product quality, color and an overall acceptance judge by the expert panelist even after 12 months of storage in room temperature.

Physico-chemical characteristics of plum in different concentrations of sodium chloride during preservation

The study was undertaken to find out the effect of sodium chloride concentration on plum to investigate the shelf life of plum in an ambient condition. There were five treatments using various sodium chloride solutions for the experiments. The stored plum firmness, color parameters, pH, acidity, β-carotene, vitamin C and TSS data were analyzed up to six months; it was noticed that in an ambient condition the plum firmness, pH, β-carotene and vitamin C content were decreased as compared to an initial as well as fresh plum but the acidity and TSS of plum was increased during storage. The color parameters of lightness decreased at prolonged storage and the color coordinates a* and b* values was responsible for the plum color during storage. However, using 8 percentage sodium chloride solutions in plum; it was found that the less decreased and increased of each quality parameters of stored plum then other concentrations of sodium chloride in an ambient condition.

Effects of various combinations of sodium chloride and sucrose concentrations on the quality of plum pickle during storage

The study was undertaken to optimize the processing of plum pickle to enhance the diversified use of the plum. There were six treatments using various sodium chloride and sucrose percentages were used for the experiments. After twelve months of storage, the pH was slightly increased and acidity was decreased during storage. In case of color of the product, the highest lightness was found using the mixture of 3 percent sodium chloride and 12 percent sucrose and the lowest was observed in 5 percent sodium chloride and 12 percent sucrose. For color co-ordinates a*, initially it was seen light red color but slowly increased during storage. Considering color co-ordinates b*, it was turn light yellow to yellow color after 12 months of storage. The microbial growths of the plum pickle were detected after 12 months of storage but these was negligible count in the plum pickle formulations using with 4 percent sodium chloride and 10 to12 percent sucrose compared with 3 to 4 percent sodium chloride used in the formulation. Comparative sensory evaluation of different quality attributes of the plum pickle is judged and finally calculated overall acceptance of the product; it was found the best formulation of plum pickle among the different treatments. The pickle was prepared using plum with 4 or 5 percent sodium chloride and 12 percent sucrose scored highest overall acceptance.

Effects of various sucrose concentrations on the quality of plum chutney during storage

The study was undertaken to optimize the processing of plum chutney to extend the variegated use of the plum. There were five treatments using various sucrose percentages were used for the experiments. The chutney was stored for six months. The p^H was slightly increased where acidity was decreased. The intensity of light yellow color of the chutney was gradually increased and turn into light red color during storage. No microbial growths of the plum chutney were seen in all the treatments up to five but in six month seen acceptable microbial count. Comparative sensory evaluation of different quality attributes of the plum chutney is judged and found the treatments T_3 (using 40 percent sucrose in plum) scored highest overall acceptance (8.0 e.g. like very much) followed by treatment T_2 (using 30 percent sugar in plum).

Influences of pretreatments and storage temperatures on the physico-chemical properties of plum

The study was undertaken to compare physico-chemical parameters and quality of the plum at different pretreatments and storage temperatures for long time use of plum. There were nine treatments using various pretreatments and temperatures for the experiments. For analyzed plum firmness, internal and external color, decay index, weight loss, pH, acidity, vitamin C, β-carotene and TSS data; it was noticed that in an ambient temperature after 7 days stored plum was spoilage but in cold room when the storage temperature was 10 ± 1^0C, the stored plum was good in condition upto 42 days; whereas the stored plum was also good in condition up to 70 days if the storage temperature was 5 ± 1^0C and the plum was wash with clean water as well as it was washed with 150 ppm NaOCL solution.

Optimization of processing technique for roasted jackfruit seed maintaining nutritional quality

Mature and full ripe jackfruit was collected from local cultivar to investigate and optimize the roasting time and temperature combination. Full ripe bulbs were first separated from the fruit and seeds were collected from the inside of the bulb. After washing with clean tap water seeds were dried in sun at ambient condition until surface water removed. The experiment was laid out with Complete Randomized Design (CRD). All the seeds were treated as roasted at 150^0 C for 10 minutes (T_1), roasted at 150^0 C for 20 minutes (T_2), roasted at 200^0 C for 10 minutes (T_3), roasted at 200^0 C for 20 minutes (T_4), roasted at 250^0 C for 10 minutes (T_5), and roasted at 250^0 C for 20 minutes (T_6). Roasted seeds were then evaluated by forming ten judgment groups using 9-hedonic scale to determine their optimum time and temperature combination for roasting. According to panel test result T_4 (200^0C for 20 minutes) scored highest overall acceptability (8.2) and regarded as best considering the quality parameters of roasted jackfruit seed.

Effect of blanching techniques and preservatives on quality and shelf life of tender green jackfruit slices

Tender green jackfruit (65-70 days) was harvested for using as vegetable during early spring and summer until the seeds hardened. The fruit matures towards the end of summer in June. The optimum stage of maturity (harvest) of jackfruit has been reported to be 90-110 days after the appearance of the spike. The experiment was laid out with Complete Randomized Design (CRD) with 6 treatments namely, blanching at 95^0C for 3 min and treated with 500 ppm KMS (T_1), blanching at 95^0C for 3 min and treated with 1000 ppm KMS (T_2), blanching at 95^0C for 3 min and treated with 1500 ppm KMS (T_3), blanching at 95^0C for 6 min and treated with 500 ppm KMS (T_4), blanching at 95^0C for 6 min and treated with 1000 ppm KMS (T_5), blanching at 95^0C for 6 min and treated with 1500 ppm KMS (T_6). Results revealed that target the enzymes were inactivated when treated with 1000 ppm KMS and blanched at 95^0C for 6 minutes (T_5). According to panel test result treatment T_5 also performed highest overall acceptability score (8.2).

20 BIOTECHNOLOGY

Protocol Development and Micropropagation

Standardization of micropropagation protocol for BARI strawberry varieties and their large-scale multiplication

Shoot tips of BARI Strawberry-2 and BARI Strawberry-3 were cultured on MS medium supplemented with different concentrations and combinations of BAP, Kn and GA_3. Four different treatments T_1, T_2, T_3, & T_4, were tested for shoot multiplication and elongation. In case of BARI Strawberry-2, for shoot elongation0.5 mg/l BAP + 0.5 mg/l Kn +1.5 mg/l GA_3 combination was found most suitable. Whereas in BARI Strawberry-3, 1.0 mg/l BAP + 0.5 mg/l Kn +1.5 mg/l GA_3 treatment was found most suitable for shoot formation.In rooting, ½MS medium without hormone produced maximum root than full MS medium in both varieties.

In vitro regeneration of Chickpea (*Cicer arietinum* L.)

Embryonal axis of BARI Chola-8 and BARI Chola-9 was used for *in vitro* regeneration. Six different treatments (T_1, T_2, T_3, T_4, T_5 & T_6) were used which consisted of TDZ alone and in combination with 2ip and Kinetin. In case of BARI Chola-8, the maximum number of shoot (19.75) was obtained from combination of 0.88 mg/l TDZ, 2.0 mg/l 2-ip and 0.4 mg/l Kn., the highest shoot length was recorded from 1 mg/l TDZ only (4.38cm) and maximum node number (3.00) from 0.44 mg/l TDZ, 1.0 mg/l 2-ip and 0.2 mg/l Kn. In BARI Chola-9, the maximum number of shoot (13.00), the highest shoot length (5.02cm) and maximum node number (3.33) were obtained from 0.44 mg/l TDZ, 1.0 mg/l 2-ip and 0.2 mg/l Kn supplemented medium.

Large-scale production of BARI released banana through tissue culture

Tissue cultured banana plantlets have good demand among the farmers. Micropropagation is an effective method to produce large-scale banana plantlets within a short period of time. In this study, sword suckers of different banana varieties developed by BARI were collected from the farm field of Pomology Division, HRC and Hill Agriculture Research Station, Raikhal. Shoot tips were separated from those suckers and cultured on different shooting and rooting medium forin vitroproduction. Fifty suckers of different varieties were cultured. More than three hundred plantlets of different varieties were produced.

In vitro regeneration of soybean

Leaf, shoot tip, cotyledon, hypocotyl, epicotyl explant of Soybean variety 'Sohag' were cultured on MS medium supplemented with different concentrations and combinations of hormones. Among the different explants, hypocotyl showed better response for the formation of callus. Cotyledonary base explants produced direct shoots in 1.0 mg/l 2ip +0.4 mg/l Kn and 2.0 mg/l BAP+0.5 mg/l NAA.

Micropropagation of date palm (*Phoenix dactylifera* L.)

Aim of this study was to develop an efficient micropropagation protocol of date palm. Offshoots and inflorescence were used as explant source. Different concentrations of IAA, NAA and 2,4-D were used for initial culture establishment. In offshoot explant, organogenesis responses were noticed after 2 months of culture in same fresh medium. In inflorescence explant, some floret showed pro-embryogenic masses and some swelled in size. But still now, no embryos or shoots were found.

In vitro regeneration of papaya (*Carica papaya* L.)

The aim of this study was to develop an efficient regeneration protocol of papaya from immature seeds. Different concentrations of 2, 4-D were used for callus formation. The highest percentage of explant produced callus (39%) in 10 mg/l 2, 4-D concentration. In regeneration, the highest shoot number (32), highest shoot length (4.33 cm), highest leaf number (7.70), higher root number (2.40) and maximum root length (2.10cm) was observed in 0.06 mg/l both BAP & NAA and 3.5 mg/l GA_3. In *ex vitro* condition all together 37% plantlets were survived. They were well established in the field and produced fruit.

Development of *in vitro* propagation protocol for gerbera

An attempt was made to develop a micro-propagation protocol of gerbera. Capitulum, leaf, petal, sepal and flower stalk explant of pink, reddish, white and orange cultivars were cultured on MS medium supplemented with four different concentrations and combinations of BAP, NAA and IAA. Early primordial emergence (7 days) was observed in white cultivar on MS medium supplemented with 2.0 mg/l BAP + 0.5 mg/l NAA and 5.0 mg/l BAP + 1.0 mg/l NAA using capitulum explant. Direct shoot initiation was observed in 20 days from sepal explant both pink and white cultivars in 2.0 mg/l BAP + 0.5 mg/l NAA supplemented medium.

Molecular genetics and genetic engineering

Marker-assisted transfer of salt tolerance (*Nax*) genes in Bangladeshi wheat varieties

An experiment was conducted to develop salt tolerant wheat varieties using marker assisted selection. Genotyping of some selected BC_3F_6 progenies (basis on previous years field performance of BC_3F_5) of the cross of two salt tolerant Australian wheat lines having Westonia background (Westonia 5907; Nax1 and Westonia 5924; Nax2) and two popular Bangladeshi wheat varieties BARI Gom-25 and BARI Gom-26 was done to confirm the presence of Nax genes . A total of 12 BC_3F_6 lines, 3 from each cross were selected comparing genotyping and field data. This 12 BC_3F_6 lines lines along with their parents were grown in a non-replicated trial for increasing volume of seeds. Seeds of all lines were harvested and preserved for further trial and other research activaties.

PCR-based detection and characterization of papaya viruses in Bangladesh

Papaya (*Carica papaya*, Caricaceae) is a major horticultural crop in Bangladesh. The tree is often infected by various pests and diseases. Papaya ringspot virus (PRSV) is the cause of one of the most important diseases of the plant which is transmitted by aphids. A total of 34 papaya leaf samples from 12 districts of Bangladesh were collected from papaya plants showing various types of symptoms consistent with virus infection. Total RNA was extracted from all of those and 32 samples were analysed by Reverse Transcription Polymerase Chain Reaction (RT-PCR) method. Twenty seven samples were found to be RT-PCR positive for Papaya ringspot virus (PRSV). Complete coat protein (CP) gene sequence was obtained from 16 sampels. Phylogenetic analysis of the 16 isolates based on the CP gene showed two major clusters having high polymorphism among the virus isolates within the clusters.

Study on relative bacterial wilt tolerance of Bt eggplant varieties and their non-Bt parent lines

Bacterial wilt is one of the most important diseases of eggplant caused by *Ralstonia solanacearum*. Eggplant samples were collected from wilt infected brinjal fields from 9 districts of Bangladesh. Bacteria was isolated from the wilted plant stem in autoclaved distilled water, cultured on TZC media and preserved in 40 percent glycerol stock solution in -80ºC. PCR of all the collected samples were carried out using the universal bacterial 16S rDNA primer set and the PCR products were sequenced. Based on sequence analysis and BLAST search four isolates were identified as *R. solanacearum*. Phylogenetic analysis showed that four sequences were closely related with *R. solanacearum* and most of the sequences were closely related to the *Enterobacter*. These results suggested that the wilting symptom of eggplant might also be caused by pathogen other than *R. solanacearum* strain. Further study is needed to confirm this result.

Collection and identification of germplasm of cultivated crops and wild species for drought and salinity stress tolerance

Salinity is a major constraint for agricultural productivity. The current study was designed to explore the variations and determine the performance of target traits to identify salt tolerant sorghum genotypes under saline conditions. Leaf number, shoot length, fresh shoot and root weight, dry shoot and root weight of 12 sorghum genotypes were evaluated under control and saline conditions. Two factor factorial analysis of variance revealed that genotypic and treatment effects were highly significant for all the studied traits. Genotype into treatment interaction (G×T) was highly significant for shoot length, fresh shoot weight, fresh root weight and dry root weight. Principal component analysis was conducted for both treatments separately. PCA converted the six traits into six different factors or components and only two (PC1 and PC2) factors had eigen value greater than 1, in Control treatment and only one (PC1) factor had eigen value greater than 1, in salt stress treatment. First one factor (PC1) contributed 65.85% and 77.61% cumulative variability in control and salt stress treatment respectively. Based on mean performance, principal component analysis and biplot graph G2, G4, G7 and G12 were better performer and G3, G5, G6, G10 were poor performer under salt stress condition. Better performing genotypes would be a good source of salt tolerant genes for development of salt tolerant crop variety.

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. Two binary vectors along with their four derivatives have been constructed for optimisation of transformation protocol. Based on the genome sequence of various ToLCV strains, DNA fragments from three diverse ToLCV species along with two tomato introns were amplified and cloned. Both the virus and intron sequences were assembled into sense/antisense configurations into *Escherichia coli* using standard protocols. In-house made vectors were tentatively named pBPA-BARI followed by a number. All the plasmid vectors were mobilised into electro-competent *Agrobacterium* cells prepared in-house and their presence in the *Agrobacterium* was confirmed by PCR analyses.

Exploring the development of gametophyte-mediated genetic transformation systems in crop plants

Genetic transformation is a powerful tool for plant improvement programmes. Most of the transformation methods developed are based on *Agrobacterium*-mediated transformation and biolistic bombardment which are time- and labour-intensive. Therefore, it is desirable to develop alternate simple and rapid transformation protocols for development of transgenic plants without a prolonged tissue culture and regeneration process. Although it has been shown that plant gametophytes could be a potential target for transformation as an alternative to produce transgenic plants, a reproducible method is still lacking in most of the crop plants. To fulfill the objectives of the experiment, tobacco microspores as a model system were used for Biolistic transformation where GUS expression was observed in bombarded microspores. Results obtained in this experiment could lead the way for an optimized system for gametphyte-mediated transformation for crop plants in future.

Validation/on-farm trials

Observational trial of tissue cultured pineapple plantlets under field condition

The experiment was conducted at Biotechnology Division research field of BARI during the period from November 2018 to June 2020. The tissue cultured plantlets of Honey Queen cultivar was used in this study. The plant height ranged from 34 to 55cm and average height was 43.77 cm. The leaf length ranged from 30 to 56cm and average length was 40.27 cm. The leaf breadth ranged from 3 to 5 cm and average breadth was 4.17 cm. The fruit length ranged from 6.00 to 8.50cm and average length was 7.26 cm. The fruit diameter ranged from 10.50 to 13.50cm and average diameter was 12.12 cm. The single fruit weight ranged from 195-392 g and average weight was 279.91 g. TSS ranged from 17.00 to 18.50%.

FtFBP research activities

Sustaining of Bt eggplant in Bangladesh by implementing effective stewardship

Stewardship is the responsible and ethical way to manage crop protection products from their discovery and development, to their use. The overall aim of the stewardship approach is to maximize the benefits, and minimize any risk, and make the technology durable. To sustain the first GE crop Bt brinjal in the long run some activities like maintenance and purification of the varieties/lines, monitoring, Bt trait assessment and expression, training programs, new seed packet with refuge management etc. were carried out during 2019-20.These activities were supportedby Feed the Future South Asia Eggplant Improvement Partnership Project.

21 SOIL MANAGEMENT

Physical Aspects of Soil Management

Determination of crop coefficient values of garlic and estimation of leaching loss of nutrients by drainage lysimeter

A study on garlic (cv. BARI Rosun-2) was conducted in the drainage lysimeter located in the Central Research Farm, BARI, Gazipur during rabi season of 2019-2020. The objectives of the study were to find out the location specific crop coefficient (Kc) values for garlic and to estimate leaching loss of nutrients. Four regimes of irrigation water were applied on the basis of depletion over field capacity (FC) at predetermined intervals such as T_1: Irrigation up to FC at 7 days interval, T_2: Irrigation up to FC at 14 days interval, T_3: Irrigation up to FC at 21days interval and T_4: Irrigation up to FC at 28 days interval. As such, 12, 9, 7 and 5 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 garlic yield (10.4 t ha^{-1}) was obtained from T_2, which was statistically identical to T_1 and T_3 but significantly higher over T_4. Therefore, Kc values were calculated from the best performed treatment, T_2. The estimated Kc values for garlic during rabi season found to be 0.94, 0.96, 1.17 and 0.80 for initial, crop development, midseason and late season stages, respectively. The Kc values derived from this experiment may be more accurate and better suited under Bangladesh contexts and alike agro-climatic conditions. Thus the values determined from the present study may be recommended for Bangladesh and similar climate elsewhere to estimate crop water requirement for garlic. This study has also collected the leachete from the lysimeter tanks from each treatment which was under the process of laboratory analysis during the preparation of report.

Synchronizationof different aged compost to crop demand, nutrient release and their contribution to the production of spinach

This study was conducted at the research field of Soil Science Division, Bangladesh Agricultural Research Institute (BARI), Gazipur under AEZ-28 during rabi season of 2019-2020 to understand the release of nutrientsfor crops and their contribution to growth and yield. Spinach cv. BARI Palongshak-2 was used for this experiment. Four different different aged composts were studied in comparison with chemical fertilizers. The treatments were T_1: 30 days aged compost (DOC), T_2: 45 days aged compost, T_3: 60 days aged compost, T_4: 75 days aged compost. Data on growth and yield attributes of spinach were collected during the crop growing season and after harvesting. Necessary soil data were also collected periodically to determine available nitrogen (N) status as well as the micrabial-respiration of soil during the experimental period. Yield and its component of spinach were significantly affected by the different aged compost. Different aged composts performed in the sequence: 45 DOC>60 DOC>30 DOC>75 DOC. The increases of yield in 45 DOC, 60 DOC, 30 DOC and 75 DOC were 78.3, 67.9, 57.5 and 20.7 % higher than yield obtained with sole use of chemical fertilizer. A significant increase in yield, fresh weight plant^{-1}, plant height and number of leaves plant^{-1}of spinach was obtained with organic amended treatments relative to only chemical fertilizer application. The hetero-tropic respiration (CO_2 emission) was found higher in soils under 30 DOC which might be due to the rapid decomposition of the semi-composted materials applied. But, the available N recorded in 45 DOC treatment was better synchronised with the crop demand which resulted in increased yield of spinach in the same treatment. Overall, compost of 45 days old was found to be the best aged compost to apply for obtaining the higher yield of crops like spinach. However, no discreet conclusion can be drawn unless the research continues for few more years.

Effect of organic and synthetic mulches on soil temperature, nutrient availability and yield of squash

A field experiment was conducted on squash cv. bulam house at the Central Research Farm, BARI, Gazipur under AEZ-28 during rabi season of 2019-2020 to study the effect of organic and synthetic mulches on soil temperature, nutrient availability and yield of squash. The treatments were T_1: no mulch (control), T_2: black polyethylene mulch, T_3: white polyethylene mulch and T_4: rice straw mulch. The experiment was laid out in a Randomized Complete Block Design (RCBD), where each treatment was replicated thrice. Data on growth and yield attributes of squash were collected during the crop growing season and after harvesting. Soil temperatures were differentially affected by the type of polyethylene mulch, with temperatures generally following the order: white polyethylene mulch>black polyethylene mulch >rice straw mulch. All plant growth characters, yield and yield contributing characters were superior with white polyethylene relative to grown without mulch (control). Treatment T_3 (white polyethylene mulch) resulted in increased single fruit weight (kg) of squash than control. Fruit yield was also increased when grown in soils under white polyethylene mulch which was 40 t ha^{-1}.

Effect of tillage method and biochar on the productivity of wheat-mungbean-t.aman rice cropping system and establishment of carbon and nitrogen footprints

A field experiment on Wheat-Mungbean-T. Aman rice cropping system was conducted in Grey Terrace Soil of Joydebpur under AEZ-28 during 2017-2018, 2018-2019 and 2019-2020, and to observe the effect of conservation tillage practice (strip tillage, ST) and different sources of organic C application on soil properties and crop yields, to find out the optimum combination of tillage practice and potential C source for soil C stabilization and, to assess C and N footprints under different tillage and C sources. The effect of conservation tillage (CT) was compared with conventional practices. In addition, four (4) carbon sources such as crop residue retention, biochar of mungbean stover, cowdung and farmer’s practice were laid out in a split plot design with 8 treatments and 3 replications. The yield of crops was found higher in soils ammended with biochar under ST and CT practices. The increased yields in biochar amended soils might be associated with higher availability of N during critical stages of the crop growth. The soil properties (e.g. available water content and soil strength) were congenial for crop production under strip tillage and biochar amended soils. Biochar amended soil under both strip and conventional planting was the best mitigation practice which diminishes the emission, relative to conventional practice. However, the experiment should be continued to determine C and N footprints.

Effect of glyphosate applied before crop establishment to the tilled or untilled soil on the growth and yield of wheat

A field experiment was conducted in Grey Terrace Soils under Madhupur Tract agro-ecological zone (AEZ-28) during 2019-2020 to observe the effect of glyphosate applied to the tilled or untilled soil before crop establishment on subsequent wheat growth. The plant back period was tested by applying glyphosate 2 and 7 days before land preparation. Disturbed soil was contrasted with undisturbed soils under two different phosphorus doses (minimum phosphorus and high dose of phosphorus) and three glyphosate doses (no glyphosate, recommended dose of glyphosate and high dose of glyphosate). Twenty four treatments were studied in split-split-plot design with three replications. The growth and yield parameters of wheat, weed biomass and P concentration were varied due to the plant back period, glyphosate and phosphorus applied to the tilled or untilled soil before crop establishment. When glyphosate applied 2 days before, emergence, germination and plant growth were hampered. When high glyphosate dose interacted with high P dose, the yield parameters and yield of crops were reduced. The phosphorus concentration in soil was also the highest recorded in the high glyphosate combined with high P dose. When glyphosate was applied at the recommended dose 7 days before land preparation, the yield and yield contributing characters were not hampered when compared with high dose of glyphosate. The key result from the experiment was the interaction of plant back period and high rate of glyphosate with high P fertilizer, leading to a strongly negative effect on wheat phenotypic and yield characters in clay loam soil. However, most of the effects were observed at the initial stage of crop growth.

Effect of conservation tillage and forms of urea on soil physico-chemical properties and the yield of gardenpea-aroid-t.aman rice cropping sequence

A field experiment on Gardenpea-Aroid-t.aman rice cropping system was conducted in Grey Terrace Soils under Madhupur Tract (AEZ-28) during 2019-2020 to observe the effect of conservation tillage practice (strip tillage) and forms of urea on soil properties and crop yields, and to explore the optimum combination of tillage practice and forms of urea in terms of yield and nutrient use. The effects of conservation tillage were compared with conventional crop establishment practice. In addition, performance of prilled urea in contrast with urea super granule were also evaluated under the crop establishment practices, laid out in a split plot design with 4 treatments and 3 replications. The yield contributing characters of garden pea (germination percentage, plant height, number of pods plant^{-1}, number of seeds pod^{-1}) were influenced by tillage practices. The yield of crops (green pod yield and grain yield) was found higher in soils under strip planting practices than conventional practices. The increased yields in strip planting practices might be associated with higher availability of N during critical stages of the crop growth. The effects of tillage practices on nutrient uptake, nitrogen use efficiency and recovery efficiency of applied N were significantly higher in strip planting practices than those in conventional practices. Soil properties like soil moisture, bulk density were not changed due to tillage practices after one season of cropping cropping under conservation tillage practice.

Effect of conservation tillage and split application of potassium on the productivity of maize- mungbean- t. aman cropping pattern and physico-chemical properties of soil

A field experiment on Maize-Mungbean-T.aman rice cropping pattern was conducted in Grey Terrace Soil of Joydebpur under AEZ-28 during rabi season of 2017-2018, 2018-2019 and 2019-2020 to observe the effect of tillage practices and timing of potassium application on soil properties and to increase the productivity of the said cropping sequence. There were 2 types of tillage practices such as strip tillage (ST) and conventional tillage (CT). In addition, 3 split application of potassium such as basal dose (K_1), two split doses (K_2) and three split doses (K_3) in a split plot design with 6 treatments and 3 replications were employed in this study. Conventional tillage gave significantly more yield than strip tillage for T.aman but strip tillage gave more yield than conventional tillage for maize. For both crops two spilt doses performed better yield than other doses. CO_2 emission was more at earlier and middle but gradually decreased later of the growing period. Availability of NH_4 was more at early and middle part when irrigation and rainfall occurred but availability of NO_3 was more when less amount of water remained in the soil. Strip tillage (ST) gave little more soil moisture than conventional tillage (CT). Conventional tillage with potassium gave less soil penetration resistance than other combinations except strip tillage with two split doses (K_2). Positive trend of improvement was observed for pH, OM, N, S, Zn and B but negative change was occurred for P and K. The third crop of third cycle T.aman was at early tillering stage at the time of prepation of report.

Effect of conservation tillage and phosphorus on the productivity of gardenpea-maize-t.aman rice cropping pattern and soil physico-chemical properties

A field experiment on Garden pea- Maize-T.aman rice cropping pattern was conducted in Grey Terrace Soil of Joydebpur under AEZ-28 during rabi 2018-2019and 2019-2020 to observe the effect of tillage practices and phosphorus on soil properties and to increase the productivity of cropping system. There were 2 types of tillage such as strip tillage (ST) and conventional tillage (CT). In addition, 3 methods of phosphorus application such as granular dose (basal) (P_1), powder doses (P_2) and granular doses (split) (P_3) in a split plot design with 6 treatments and 3 replications. Strip tillage gave higher yield than conventional tillage for pea ($p \leq 0.05$) but vice-versa for T.aman rice ($p \geq 0.05$). Powdered forms of P as basal significantly performed the best than other phosphorus doses for both crops. Strip tillage with phosphorus combinations comparatively conserved more moisture than conventional tillage with phosphorus combinations and vice-versa for penetration resistance. pH, OM, N, S, Zn and B increased but P and K content more or less remain unchanged compare to initial soil. The 6th crop T.aman rice was in tillering stage.

Effect of crop establishment practices and IPNS based nutrient management on vegetable based cropping system and soil physical health

A field experiment on Cabbage-Indian spinach-T.aman rice cropping pattern were conducted in Grey Terrace soil of Joydebpur under AEZ-28 during rabi season of 2019-2020 to investigate the performance of crops in vegetable based triple crops cropping system under the crop establishment and organic fertilizer application practices and to study the soil health. There were 2 types of tillage such as strip tillage (ST) and conventional tillage (CT). In addition, 3 nutrient management practices such as 100% organic manure, IPNS and 100% chemical fertilizers in a split plot design with 6 treatments and 3 replications. IPNS package (60% chemical fertilizer with 40% organic fertilizer) significantly gave the highest marketable yield than other nutrient management packages. Indian spinach was damaged due to shower at early vegetative stage. Third crop T. aman was in tillering stage at the time or report preparation.

Effect of minimum tillage and plant residue mulching on wheat cultivation in coastal saline areas of Bangladesh

In the coastal saline areas of Bangladesh, planting a crop in the residues of the previous crop along with minimal disturbance of soil can be a successful and sustainable cropping practice. Considering these aspects, a field experiment was conducted to evaluate the best tillage practice for wheat in saline areas and observe the effect of permanent soil cover on wheat at Agricultural Research Station (ARS), Benarpota, Satkhira during the rabi season of 2019-2020. Wheat cultivation as farmers' practice (T_1), relay of wheat with and without residue (T_2 and T_3, respectively), strip tillage of wheat with and without residue (T_4 and T_5, respectively) as well as cultivation by Power Tiller Operated Seeder (T_6) were taken as treatments in a randomized complete block design with three replications. Except initial plant population, final plant population and days to heading and maturity; all other plant characters like plant height, spikelets spike^{-1}, grains spike^{-1}, 1000 grain weight, grain and straw yield were significantly influenced by the sowing method and residue retention. Comparing the performance of different methods of sowing, strip tillage of wheat with residue (T_4) produced the highest grain yield (3.53 t ha^{-1}) over relay production of wheat. Relay of wheat with and without residue gave statistically identical yield which was inferior to rest of the treatments. Timely sowing through agro-machineries exerted significant influence on the grain set and yield of wheat. Considering yield and variable cost, the highest gross margin (Tk. 46050ha^{-1}) and benefit cost ratio (1.77) were obtained from T_4 where strip tillage with residue were practiced vigilantly.

Effect of seed priming and planting method on soil salinity amelioration and yield of sunflower in south-western Bangladesh

An experiment was conducted at Agricultural Research Station (ARS), BARI, Benarpota, Satkhira during rabi season of 2019-2020 to study the combined effect of seed priming and planting method on soil salinity and yield of sunflower. The experiment was conducted in two factors RCB design with 12 treatments. Factor A was seed priming considering 4 levels viz. No priming, Hydro–priming for 24 hours, Hydro–priming for 48 hours and Halo–priming for 48 hours (1% NaCl solution). On the other hand, factor B was planting method and depth considering 3 levels viz. dibbling (1-5cm), reduced tillage (6-10 cm), Conventional Tillage (12-15 cm). It was revealed that among different treatment combinations RT along with HP for 48H produced the highest seed yield (1.65t ha-

1). Although Dibbling with HP for 48H gave the statistically similar yield with RT along with HP for 48H. Yield obtained from Dibbling+HP 48H (1% NaCl) and RT+HP 48H (1% NaCl) were statistically identical. The lowest seed yield (0.98 t ha^{-1}) was recorded in CT+NP. The lowest level of soil salinity was recorded during sowing period in all treatment plots and the highest level of salinity (6.83 dSm^{-1}) was recorded for Dibbling with 24 hours HP at the harvesting stage.

Chemical Aspects of Soil Management

Nutrient management for sustaining soil fertility and yield of wheat-mungbean-t.aman cropping pattern

A long term field experiment on Wheat-Mungbean-T.aman cropping pattern was carried out in High Ganges Floodplain Soils (AEZ-11) of RARS, Jashore during the year of 2000- 2001 to 2019-2020. The objectives were to find out sustainable fertilizer recommendations, monitor soil health, estimate uptake of different nutrients for the cropping pattern and 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. Results showed consistently the highest yield from each of the crops of the pattern obtained with 125% RD treatment which was statistically similar to 100% RD. The highest rice equivalent yield (REY) of 13.02 t ha^{-1} $year^{-1}$ was obtained from T_1 (125% RD). The lowest REY (6.90 t ha^{-1} $year^{-1}$) was obtained from control (T_6). The highest gross margin of 119618 Tk^{-1} ha^{-1} yr^{-1} was also obtained from T_1 treatment (125% RD).The highest benefit cost ratio of 1.85 was found in T_1 (125% RD).

Nutrient management for sustaining soil fertility and yield of mustard-mungbean-t.aman cropping

A long term field trial on Mustard-Mungbean-T.aman cropping pattern was conducted in High Ganges River Floodplain Soils (AEZ-11) of RARS, Jashore during the year of 2000- 2001 to 2019-2020. 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 combined effect of 120-54-70-40-3-1 kg ha^{-1} of NPKSZnB (T_5) produced the highest seed yield (1.51 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. The highest rice equivalent yield (REY) of 14.35 t ha^{-1} $year^{-1}$ was obtained from T_5 treatment. The lowest REY (8.30 t ha^{-1} $year^{-1}$) was obtained from control i.e. native fertility treatment (T_8). The highest gross margin of 126389 $Tk^{-1}ha^{-1}yr^{-1}$and BCR of 1.79 was 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 nineteen 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 balances were found negitive while P balance was positive.

Effect of poultry litter biochar on maize (Khoibhutta) in acidic soil

The study was conducted at the central research farm, Gazipur under Grey Terrace Soil (AEZ-28) to investigate the effect of combined use of chemical fertilizer and poultry litter biochar (PLB) on maize (cv. BARI Khoibhutta) in acidic soil during 2018-2019 and 2019-2020. Three rates of poultry litter (PL) and PLB (3, 6, and 9 t ha^{-1}), compare to dolomaite @ 1 t ha^{-1} and no amending materials with recommended dose chemical fertilizer (RDCF) were used in this study. The incorporation of biochar tended to reduce soil bulk density. Moreover, total soil porosity, soil pH, total nitrogen, soil organic carbon, available phosphorus and potassium were significantly increased in soil due to application of biochar. Compared to PL, PLB exhibited a higher soil pH and organic carbonwhere the magnitude of increase depended on the amount of biochar incorporation in soil. Two years average yield of Khoibhutta using RDCF was 3.42 t ha^{-1} but, PLB increased the grain yield ranging from 4.41 t ha^{-1} to 5.26 t ha^{-1}, where the highest yield was found with addition of 9 t ha^{-1} PLB. Compared with the unamended control, yield increase up to 47% at 9 t $ha^{-1}$of biochar treated soil, whereas yield increases 6% at 1 t ha^{-1} of dolomite treated soil. The highest total organic carbon was obtained where higher dose of biochar applied, which leads to an increase in soil organic carbon. The overall result indicated that RDCF with 9 t ha^{-1}PLB is more effective for Khoibutta yield and improvement of soil fertility.

Effect of crop residue and their biochars on maize yield

A field study was conducted on the effect of crop straw and their derived biochars on maize (BARI Khoibhutta) yield at the central research farm, BARI, Gazipur under Grey Terrace Soil (AEZ-28) during rabi seasons of 2018-2019 and 2019-2020.Three crop straws (i.e. groundnut straw, chickpea straw and mustard straw) and their derived biochars were used where cowdung used as comparison. The experiment consisted of eight treatments laid out in randomized complete block design with three replications. Results indicated biochar, especially those were high in pH, enhanced soil pH (>0.2 units, $p < 0.05$), whereas reduction and or unchanged soil pH was observed among treatments with crop straws. The organic matter content increased with the application of crop straws and biochars as well as cowdung. The incorporation of crop straw biochars produced from crop straws increased soil pH ranges from 0.28~0.39 unit, and their ameliorating effects varied due to raw materials of biochars. Initially, carbon stock increased ranges from 0.07 to 0.08% by using crop straw and crop straw derived biochar increased around 30% over initial soil organic carbon (0.27%). The carbon content decreased about 50% from CD treatment and 30% from straws but biochar amended plot reduced only about 2% carbon over the first year status. Higher nutrient uptake by maize was observed with the treatment receiving biochar compared to crop straws as well as cowdung and no amendment plots. The lowest uptake of nutrient element was recorded in treatment receiving amendment plot (100% RDCF). The incorporation of biochar not only neutralized soil acidity, but can also improve soil fertility and carbon stock in soil. Two years average results on the yield parameters of the BARI Khoibhutta showed that crop straw increased the grain yield from 4.63 t ha^{-1} to 4.75 t ha^{-1} where crop straw biochar increased 5.24 t ha^{-1} to 5.80 t ha^{-1}, where 4.48 t ha^{-1} yield obtained from RDCF with cowdung 5 t ha^{-1}. Crop straw biochar enhanced the yield up to 43% from RDCF and 25% from crop straw. The overall result indicated that RDCF with 10 t ha^{-1} chickpea straw biochar (CSB) out of three crop staw biochars showed more effective for Khoibutta yield and improve soil fertility. Further study is needed to observe the stability of carbon in soil as influenced by biochar application.

Effect of biochar on yield and nutrient uptake of cabbage

A field study was conducted in Grey Terrace Soil of Central Research Farm, BARI under AEZ-28 during rabi season of 2019-2020 to investigate the effect of rice husk biochar (RHB) on soil fertility, carbon sequestration, yield and nutrient uptake by cabbage. The experiment consisted in a randomized complete block design with eight treatments i.e. control, 100% recommendation dose of chemical fertilizer (RDCF) and three rates of biochar (1.5, 3.0 and 4.5 t ha^{-1}) with 100% or 80% RDCF. Application of RHB improved soil pH and concentrations of organic matter, N, P, K, Ca and Mg, root length, yield and yield components of cabbage ($p<0.05$). Soil fertilized with chemical fertilizers had lower soil pH (5.38) than all other treatments but 0.13 unit increased by 4.5 t ha^{-1} RHB with 80% RDCF treated soil. Application RHB tended to decrease bulk density of soil and increase of soil organic carbon (SOC) stock. Irrespective of treatments, the highest carbon accumulation was recorded in soil amended with 4.5 t ha^{-1} of RHB. Compared to control, more than 179% yield increase by using 100% RDCF in soil was observed. In addition, 100% RDCF with different dose of RHB contributed to yield increase ranging from 226 to 299% and 203 to 281% for the reduction of 20% RDCF. Compare to 100% RDCF with different dose of RHB yield increased varied 17 to 43% and 9 to 37% yield increased due to reduction of 20% RDCF. The correlation coefficient betweenSOC and marketable yield were 0.9587. The highest gross margin was obtained from T_5 treatment with a BCR 3.93 but imidiate lowest 3.81 was found in T_8 treatment where 20% RDCF were reduced from T_5 treatment. Application of more stable component like biochar instead of easily degraded organic amendments showed healthy growth and yield of cabbage. For more confirmation, the trial needs to continue in the next year.

Development of fertilizer recommendation for cauliflower with maize intercropping system

An experiment was conducted at BARI Central Research Station, Gazipur during the rabi season of 2019-2020. The experiment was set up with nine treatments viz. T_1 (100% RDCF of Maize + 0% RDCF of Cauliflower), T_2 (100% RDCF of Maize + 10% RDCF of Cauliflower), T_3 (100% RDCF of Maize + 20% RDCF of Cauliflower), T_4 (100% RDCF of Maize + 30% RDCF of Cauliflower), T_5 (100% RDCF of Maize + 40% RDCF of Cauliflower), T_6 (100% RDCF of Maize + 50% RDCF of Cauliflower), T_7 (100% RDCF of Maize + 60% RDCF of Cauliflower), T_8 [Sole Maize (100% RDCF of Maize with recommended spacing)] and T_9 [Sole Cauliflower (100% RDCF of Cauliflower with recommended spacing)]. Both maize and cauliflower significantly influenced by different treatments**.** Average highest maize equivalent yield of 30.88 t ha^{-1} was obtained from T_7 treatment (100% RDCF of Maize + 60% RDCF of Cauliflower). Economic analysis revealed that highest BCR of 5.04 was obtained from T_6 treatment (100% RDCF of Maize + 50% RDCF of Cauliflower). BCR in sole maize and sole cauliflower were 2.69 and 4.91, respectively. Nitrogen, potassium and sulpher balances were found negetive where as phosphorus balance was found positive.

Efficacy of different form of urea on nitrogen availabilityand yield of maize

An experiment was conducted at BARI, Gazipur during rabi season of 2019-2020 with the objectives to : i) find out use efficiency of different forms of urea, ii) observe the yield and yield components of maize as influenced by different form of urea and iii) analyze cost and return of maize produced from different form of urea. There were four treatments viz. T_1: N-control, T_2: RD of nitrogen (225 kgha^{-1}) in the form of prilled urea, T_3: Application of 200 kg nitrogenha^{-1} in the form of urea super granule (USG), T_4: Application of 205 kg nitrogenha^{-1} in the form of neem coated urea. P, K, S, Zn & B were applied @ 60, 110, 40, 4 & 1.4 kg ha^{-1}, respectively The highest yield (9.89 t ha^{-1}) of maize was obtained from T_3 treatment (200 kg N ha^{-1}as USG) which was statistically similar to T_4 treatment (9.32 t ha^{-1}). The lowest yield (5.92 t ha^{-1}) of maize was noted in N-control treatment (T_1). The actual nitrogen add(130 kg ha^{-1}), nitrogen uptake (188 kg ha^{-1}) and nitrogen balance (-58 kg ha^{-1}) by maize was highest in T_3 treatment. If 1 kg extra nitrogen applied, 19.85 kg extra maize grain yield over N-control was observed in T_3 treatment. Cost and return analysis revealed that highest gross margin (78291 Tk. ha^{-1}) as well as BCR of 2.13 was obtained from T_4 treatment (Neem coated urea applied maize plot). BCR in prilled urea and USG applied maize were 2.04 and 2.08, respectively.

Effect of different sources of organic manures on the yield of cauliflower

A field experiment on the effect of different sources of organic manure on cauliflower was conducted in the Grey Terrace Soil (AEZ-28) of Gazipur during the years of 2017-2018, 2018-2019 and 2019-2020 to find out suitable organic manure for vegetable production and to find out the efficacy of different organic manures on producing vegetables. There were eight treatments viz. T_1: Native nutrient, T_2: Poultry manure @ 10 t ha^{-1}, T_3: Cowdung @ 20 t ha^{-1}, T_4: Farm Yard Manure @ 18 t ha^{-1}, T_5: Vermicompost @ 15 t ha^{-1}, T_6: Compost @ 15 t ha^{-1}, T_7: Tricho-Compost @ 10 t ha^{-1}, T_8: Bioslurry @ 15 t ha^{-1}. Data revealed that the T_5 treatment produced the highest average yield of cauliflower 43.20 t ha^{-1}. The native nutrient treatment produced the lowest average yield of 12.82 t ha^{-1}. The uptake of nutrients by cauliflower curd was highest in the treatment T_5 (vermicompost). The highest gross margin (1023200 Tk.ha^{-1}) and MBCR (6.63) was noted from T_8 (Bioslurry)treatment.

Effect of bioslurry and chemical fertilizer on the yield and quality of onion

An experiment was conducted in the Central Research Farm, BARI, Gazipur during rabi seasons of 2017-18, 2018-2019 and 2019-2020 to find out the effect of bioslurry on the yield and yield components of onion and to find out nutrient uptake as influenced by different sources of bioslurry. There were eleven treatments viz. T_1: Native fertility, T_2: 75% Soil Test Based (STB) fertilizer, T_3: 75% STB + 3 t ha^{-1} Poultry Manure (PM), T_4: 75% STB + 3 t ha^{-1} PM slurry, T_5: 75% STB + 5 t ha^{-1} Cowdung (CD), T_6: 75% STB + 5 t ha^{-1} CD slurry, T_7: 100% STB, T_8: 100% STB + 3 t ha^{-1} PM, T_9: 100% STB + 3 t ha^{-1} PM slurry, T_{10}: 100% STB + 5 t ha^{-1} CD, T_{11}: 100% STB + 5 t ha^{-1} CD slurry. The highest yield of onion (13.52 t ha^{-1} in 2018, 12.82 t ha^{-1} in 2019 and 14.19t ha^{-1} in 2020) were obtained from T_{11} treatment (100% STB chemical fertilizers + 5 t CD slurry ha^{-1}). The lowest yield of onion (7.53 t ha^{-1} in 2018, 5.51 t ha^{-1} in 2019 and 6.16 t ha^{-1} in 2020) was noted in native fertility treatment (T_1). Total Soluble Solid (TSS) content (17.15%) of onion bulb was recorded higher in T_{11} treatment (100% STB chemical fertilizers + 5 t ha^{-1} cowdung slurry). The uptake of nutrients by onion bulb was highest in the treatment T_{11} (100% STB + 5 t ha^{-1} cowdung slurry) followed by T_9 (100% STB chemical fertilizers + 3 t ha^{-1} Poultry Manure slurry). The highest gross return (2,70,200 Tk $ha^{-1}yr^{-1}$), gross margin (1,19,583 Tk $ha^{-1}yr^{-1}$) and marginal value product (1,42,200 Tk $ha^{-1}yr^{-1}$) were obtained from T_{11} (100% STB + 5 t ha^{-1} CD slurry) treatment.

Effect of organic manures on cabbage yield and carbon accumulation in soil

A field experiment to observe the effect of organic manure on cabbage yield and carbon accumulation in soil was conducted in the Grey Terrace Soil of Gazipur (AEZ-28) during the year of 2018-2019 and 2019-2020. The objectives were to improve the stock of organic carbon in the soil and to increase cabbage yield through integrated plant nutrition system (IPNS). 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. Results revealed that the T_6 (VC + IPNS) treatment produced the highest yield of cabbage (85.5 t ha^{-1}in 2019 and 85.8t ha^{-1}in 2020). This trend of influence was consistent for almost all the yield contributing characters of cabbage. The native nutrient treatment produced the lowest yield (11.0 t ha^{-1}in 2019 and 12.1 t ha^{-1}in 2020). The highest nutrient uptake by cabbage was noted in T_6 treatment. IPNS through vermicompost improved nutrient status in post harvest soil. Organic manures also increased accumulation of organic carbon in soil. Highest gross return (8,56,600 Tk. ha^{-1}) was obtained in T_6 (VC + IPNS) treatment but BCR was lower in this treatment due to high price of vermicompost. The highest BCR (6.27) was found in T_5 (PM + IPNS).

Development of fertilizer recommendation for Mustard-Mungbean-Jute-T. aman rice cropping pattern

A field experiment on Mustard-Mungbean-Jute-T.Aman cropping pattern was conducted at Jashore (AEZ-11) and Jamalpur (AEZ-9) during the year of 2018-2019 and 2019-2020 with the objectives were to find out suitable fertilizer combination for sustainable yield of the pattern, monitoring soil health as influenced by chemical fertilizers and to make a balanced sheet of each nutrient. There were eight 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. Data revealed that the grain yield of Mustard (BARI Sarisha-14), Mungbean (BARI Mug-6) and T. Aman (BRRI dhan57), and fibre yield of Jute (O-9897) were significantly influenced by the fertilizer treatments. The highest yield was obtained from T_6 treatment where 25% additional NPK was added over 100% STB rate.

Nutrient management for a rooftop garden

The study was conducted in Gazipur (rooftop of Soil Science Division) during the year of 2018-2019 and 2019-2020. The experiment activities included fertilizer management of some vegetables, fruits and flowers; and influence of different ratio of soil and organic materials on the yield and yield components of vegetables, fruits and flowers for rooftop garden. Prior to setting the experiments initial soil samples as well as organic fertilizers were analyzed and nutrient contents were determined. For vegetables, fruits and flowers experiments, T_7 treatment (80% of T_1 + 2 kg vermicompost 6 kg^{-1} soil) showed best performance followed by T_3 treatment (80% of T_1 + 2 kg kitchen waste 6 kg^{-1} soil) for maximizing the yield of vegetables and flowers grown on the rooftop garden. Vegetables (sweet pepper, bottlegourd & bitter gourd), fruits (strawberry) and flowers (gladiolus & gerbeara) performed better in T_5

treatment (1 kg vermicompost for 1 kg soil) compared to others in the experiments related to influence of different ratio of soil and organic materials on the yield and yield components of vegetables, fruits and flowers for rooftop garden. The lowest yield was recorded from the T_4 treatment (1 kg cowdung for 2 kg soil). Resuts showed that, T_5 treatment gave 20-240% higher yield over other treatments.

Effect of integrated nutrient management on the yield and nutrient uptake of foxtail millet

A field experiment was conducted at the Central Research Farm, BARI, Gazipur and Regional Agricultural Research Station (RARS), Jamalpur during rabi season of 2019-2020 to evaluate the effect of integrated nutrient management for better yield of foxtail millet; and to increase soil fertility and sustain crop productivity. Six treatment combinations viz. T_1 = Soil test based fertilizer dose for high yield goal (HYG), T_2= IPNS with 5 t ha^{-1} cowdung, T_3 = IPNS with 5 t ha^{-1} compost, T_4 = IPNS with 1.5 t ha^{-1} vermicompost, T_5 = IPNS with 3.0 t ha^{-1} poultry manure and T_6 = Absolute control were tested with BARI Kaon-2 variety. The IPNS treatment combinations are significantly different from rest of the treatments in terms of yield and economic return. The significantly highest grain yield (2.38 t ha^{-1} and 2.26 t ha^{-1} at Gazipur and Jamalpur, respectively) was recorded in IPNS with 1.5 t ha^{-1} vermicompost treated plot (T_4).The uptake of nutrients by foxtail millet was highest in the treatment T_4 receiving IPNS with 1.5 t ha^{-1} vermicompost which was followed by T_5 (IPNS with 3.0 t ha^{-1}poultry manure) in both the locations. The highest gross return (132010 Tk. ha^{-1} and126060 Tk. ha^{-1} at Gazipur and Jamalpur, respectively), net return (73700 Tk. ha^{-1} and 68545 Tk. ha^{-1} at Gazipur and Jamalpur, respectively) as well as BCR (2.26 and 2.19 at Gazipur and Jamalpur, respectively) were obtained from T_4 treatment (IPNS with 1.5 t ha^{-1} vermicompost). The overall results indicated that IPNS with 1.5 t ha^{-1} vermicompost (T_4 treatment) appeared to be more effective than other fertilizer management packages in respect of yield as well as economic return for foxtail millet cultivation at Gazipur and Jamalpur.

Effect of biochar and chemical fertilizers in different bed condition on the growth and yield of brinjal

A field trial was conducted at Regional Agricultural Research Station (RARS), Jamalpur during the period of 2018-2019. The objectives of the study were to observe the biochar and chemical fertilizers in different bed condition to improve the soil health and increase the yield.The experiment was laid out in randomized complete block (RCB) design with two factors (biochar rate and different bed conditions) having three treatments in each factors with 3 replications. Three biochar rate were:C_1= 100% Recommended Dose of Chemical Fertilizer (RDCF) +biochar(0 t ha $^{-1}$), C_2 = C_1 + biochar (5t ha^{-1}) and C_3= C_1 + biochar (10 t ha^{-1}) and three bed conditions were:B_1 = flat bed (0 cm), B_2 = normal bed (8 cm) and B_3 =raised bed (15 cm). There were nine treatment combinations. The highest number of leaves, the total fresh and dry weight showed a positive effect with the biochar addition compared to the no addition of the biochar under different bed conditions. The highest yield (40.47 t ha^{-1}) was obtained from the combination of biochar (10 t ha^{-1}) under normal (8 cm) bed condition which was statistically identical with the combination of biochar (10 tha $^{-1}$) with raised (15 cm) bed condition. The lowest yield (34.18 t ha $^{-1}$) was obtained from the combination of biochar (0 t ha^{-1}) with flat (0 cm) bed condition. Moreover, biochars can be used as soil amendment for sustainable yield of crops and better soil health.

Development of fertilizer recommendation for garlic with coriander intercropping system

An experiment was conducted in the Central Research Farm, BARI, Gazipur and On Farm Research Division, BARI, Noakhali during Rabi season of 2017-2018, 2018-2019 and 2019-2020 to develop a fertilizer recommendation for chilli with garlic intercropping system. Six treatment combinations viz. T_1= 100% RDCF of chilli + 0% RDCF of garlic, T_2= 100% RDCF of chilli +10% RDCF of garlic, T_3= 100% RDCF of chilli + 20% RDCF of garlic, T_4= 100% RDCF of chilli +30% RDCF of garlic, T_5= 100% RDCF of chilli +40% RDCF of garlic and T_6= 100% RDCF of chilli +50% RDCF of garlic were tested. Both chilli and garlic significantly influenced by different treatment combinations. Significantly highest yield of chilli (10.12 and 9.10 t ha^{-1} at Gazipur and Noakhali, respectively) and garlic (3.70 and 3.55 t ha^{-1} at Gazipur and Noakhali, respectively) were obtained from T_6 treatment (100% RDCF of chilli + 50% RDCF of garlic) which was statistically similar to T_5 treatment (100% RDCF of chilli +40% RDCF of garlic). Chilli equivalent yield (CEY) progressively increased with the increasing rates of inorganic fertilizers. The results showed that T_6 provided the highest CEY (17.52 and 16.18 t ha^{-1} at Gazipur and Noakhali, respectively) followed by T_5 (17.47 and 16.14 t ha^{-1} at Gazipur and Noakhali, respectively). The highest net return (339755 Tk. ha^{-1} and 310198 Tk. ha^{-1}at Gazipur and Noakhali, respectively) as well as BCR (4.50 and 4.32 at Gazipur and Noakhali, respectively) were obtained from T_5 treatment (100% RDCF of chilli +40% RDCF of garlic) while the lowest net return (266661 Tk. ha^{-1} and 242264 Tk. ha^{-1}at Gazipur and Noakhali, respectively) as well as BCR (3.92 and 3.76 at Gazipur and Noakhali, respectively) were observed from T_1 treatment (100% RDCF of chilli + 0% RDCF of garlic).

Comparative study on the effectiveness of TSP and DAP fertilizer for brinjal cultivation

An experiment was conducted in the research farm of Regional Agricultural Research Station (RARS), Jamalpur during the period of 2018-2019 and 2019-2020 to find out suitable phosphorus fertilizer source and application method for higher yield of brinjal and to increase phosphorus use efficiency. There were six treatments comprising T_1 = P from TSP (100% basal dose), T_2 = P from DAP (100% basal dose), T_3 = P from DAP (50 % basal + 50% top dress), T_4= P from DAP (25 % basal + 75 % top dress), T_5 = P from DAP (100 % top dress) and T_6 = P-control. NKSZnB were used as a blanket dose in all treatment. Two years results revealed that, DAP fertilizer gave superior performance over TSP fertilizer. The highest average brinjal fruit yield (33.13 t ha^{-1}) was found in T_3 treatment [DAP application (50 % basal + 50% top dress)] compared to TSP treatment (30.05 t ha^{-1}) and the lowest (17.97 t ha^{-1}) was obtained from T_6 (control) treatment). The highest phosphorus use efficiency (433.14 kg yield/kg P) and highest phosphorus recovery (28.75%) were also obtained from DAP treatment with highest BCR (3.6). It may be concluded that, split application of DAP fertilizer led to an increased of P availability at the proper time of demand which might have contributed to the yield of brinjal.

Effect of biochar and vermicompost as an organic soil amendment in sweet orange

A field experiment on sweet orange (Citrus sinensis L.) was conducted in Regional Agricultural Research Station (RARS), Jamalpur with the objectives to investigate the effect of biochar and vermicompost on the growth and fruit yield of sweet orange and to develop soil fertility through inclusion of biochar and vermicompost. The experiment started in 2017-2018 and it completed its third year cycle in 2019-2020. There were four treatments comprising T_1: Biochar + IPNS based chemical fertilizer, T_2: Vermicompost + IPNS based chemical ferrtilizer, T_3: Biochar + vermicompost + IPNS based chemical fertilizer and T_4: chemical fertilizer. Results revealed that T_3 treatment i.e. Biochar + vermicompost + IPNS based chemical fertilizer showed its best results with respect to vegetative and fruit characters of sweet orange plant. Among four treatments, the highest average fruit yield (8.10 t ha^{-1}) was recorded in T_3 treatment (biochar-vermicompost combination treatment) and the lowest (5.38 t ha^{-1}) was found in control T_4 (chemical fertilizer) treatment. Soil organic carbon (SOC), total N, available P, K and S contents in post-harvest soil were also highest in T_3 treatment. The overall results indicate that application of biochar @ 4 kg tree^{-1} in combination with vermicompost @ 2 kg tree^{-1} and IPNS based chemical fertilizer was most effective in increasing sweet orange yield and carbon accumulation in soil than sole application of biochar or vermicompost in combination with recommended doses of chemical fertilizers.

Integrated nutrient management for sweet orange

An experiment was conducted at Regional Agricultural Research Station (RARS), Jamalpur with the objectives to develop suitable and economic fertilizer dose for sweet orange cultivation through integrated nutrient management (INM) and to quantify the changes in soil health due to addition of organic manure. The experiment started in 2016-2017 and in 2019-2020, it completed its fourth year cycle. There were seven treatments viz. T_1: 100% RDCF ($N_{169}P_{79}K_{88}S_{18}Zn_3B_1$), T_2: Cowdung 5 tha^{-1} + IPNS based inorganic fertilizer ($N_{144}P_{72}K_{76}S_{18}Zn_3B_1$), T_3: Cowdung 10 tha^{-1} + IPNS based inorganic fertilizer ($N_{119}P_{64}K_{65}S_{18}Zn_3B_1$), T_4: Poultry manure 3 tha^{-1} + IPNS based inorganic fertilizer, ($N_{151}P_{69}K_{74}S_{18}Zn_3B_1$), T_5: Poultry manure 5 tha^{-1} + IPNS based inorganic fertilizer, ($N_{139}P_{62}K_{64}S_{18}Zn_3B_1$), T_6: 125% RDCF ($N_{212}P_{99}K_{110}S_{18}Zn_3B_1$) and T_7: control. The tested variety was BARI Malta-1. Results revealed that, T_4 treatment (Poultry manure 3 t ha^{-1} + IPNS based inorganic fertilizer) produced the highest average sweet orange yield (7.23 t ha^{-1}) and the lowest yield (1.85 t ha^{-1}) was recorded in control (T_7). Organic carbon (SOC), total N, available P, K and S contents in post-harvest soil were also higher in T_4 treatment.

Effect of biochar and chemical fertilizers in different bed condition on the growth and yield of brinjal

A study was conducted in the research field of Regional Agricultural Research Station (RARS), Jamalpur during the year of 2018-2019 and 2019-2020. The objectives of the study were to observe the effect of biochar and chemical fertilizers on the yield of brinjal and to improve the soil health under different bed conditions. The experiment was laid out in a Randomized Complete Block (RCB) design having two factors (biochar rate and different bed conditions) with three replications. Three biochar rate were:C_1= 100% Recommended Dose of Chemical Fertilizer +biochar (0 t ha $^{-1}$), C_2 = C_1 + biochar (5t ha^{-1}) and C_3= C_1 + biochar (10 t ha $^{-1}$) and three bed conditions were: B_1 = flat bed (0 cm), B_2 = normal bed (8 cm) and B_3 = raised bed (15 cm). The highest number of leaves, total fresh and dry weight showed positive effect due to biochar addition compared to no addition of biochar in soil under different bed conditions. The individual fruit weight, fruit length, fruit diameter, fruit no. plant $^{-1}$and yield showed significant results. The highest yield (40.47 t ha^{-1}) during 2018-2019 and 39.62 t ha^{-1} during 2019-2020 was obtained due to application of biochar (10 t ha^{-1}) under normal (8 cm) bed condition which was followed by biochar (10 t ha^{-1}) under raised (15 cm) bed condition in both the years. The lowest yield (35.18 t ha^{-1}) and (33.92 t ha^{-1}) was obtained from control (biochar (0 t ha^{-1}) under flat (0 cm) bed condition) for the first year and second year respectively. Moreover, biochar may be used as amendment for improving soil fertility.

Micronutrient Aspects of Soil Management

Bioremediation of heavy metal polluted soil from industrial effluents polluted areas using microbes and biochar

A pot study was conducted by growing Maize (Zea mays) in metal contaminated soil (10 kg pot^{-1}) and soils treated with microbes and biochar to determine the effects of microbes and biochar for the remediation of heavy metal contaminated soil. The results showed that Pb, Cd, and Ni, uptake by maize increased due to application of microbes. Application of biochar might have immobilized metals in soil and decreased the metal content in plants, except Cr. The uptake of metal increased in maize due to application of microbes compared to polluted control by 2.47 to 50.0, 10.3 to 22.6, and 7.15 to 12.4%, respectively for rhizobium, azotobacter, and phosphorus solubilizing bacteria. While metal uptake decreased for water hyacinth, barnyard grass and fern derived biochar by 22.9 to 54.8, 28.1 to 50.0 and 30.4 to 67.2%, respectively. On the other hand, chromium uptake was increased by 42.6 to 51.2 % in maize plants due to biochar application. The highest value of transfer coefficient (Cr–0.61) was found in plant grown in barnyard grass biochar treatment and lowest (Cd–0.07) was in water hyacinth biochar. Addition of microbes and biochar materials in contaminated soil did not totally restrict the uptake of heavy metal by maize plants. The variation in effectiveness of microbes and biochar application on heavy metal uptake by maize plant could be due to the nature and type of amendments. However, mobilization or immobilization techniques might be used to remediate soil which contaminated with heavy metal.

Effect of seed priming on yield and nutrient uptake of cauliflower

A field experiment on cauliflower was conducted in Grey Terrace Soil (AEZ-28) of Gazipur during the year of 2019-2020 to observe the role of seed priming on growth, yield, quality and nutrient uptake of cauliflower. There were six treatments viz. T_1: Control (without priming), T_2: Hydropriming (soaked with distilled water), T_3: Seed soaked with 0.05% zinc, T_4: Seed soaked with 0.01% boron, T_5: Seed soaked with 0.05% zinc and 0.01% boron and T_6: Seed soaked with sand matrix. The experiment was laid out in RCB design with three replications. The combined use of micronutrients seed priming gave the highest curd yield of cauliflower (55.1t ha^{-1}). The same trend was observed for the yield contributing characters of cauliflower. The untreated treatment produced the lowest yield (28.8 t ha^{-1}). The highest zinc and boron uptake was found in T_5 treatment (seed soaked with zinc and boron).

Growth, yield and bulb quality of onion (*Allium cepa* l.) as influenced by foliar application of zinc and boron

A field experiment was carried out in the micronutrient experimental field, Soil Science Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during 2019-2020 with a view to observe the growth, yield and bulb quality of onion (*Allium cepa* L.) for foliar application of zinc and boron. The experiment was laid out in a split plot design with three replications. There were 16 treatment combinations comprising 4 levels each of boron (0, 0.01, 0.02 and 0.05%) and zinc (0, 0.01, 0.02 and 0.05%).The integrated use of zinc and boron was found superior to their single applications. The interaction effect between zinc and boron was significant in case of bulb weight and yield of onion. The highest bulb yield (15.1 t ha^{-1}) was found in T_{16} ($Zn_{0.05}B_{0.05\%}$) treatment which was significantly higher over single application of either zinc or boron and control. The yield benefit over control varied from 51.9 to 73.6% due to interaction effect.

Effect of zinc and boron application on the yield and nutrient uptake of coriander

A field experiment was conducted during rabi season of 2019-2020 in the research field of Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur to find out a suitable combination of zinc and boron for coriander production and to estimate zinc and boron content and uptake both leaves and seeds of coriander. There were 16 treatments combinations comprising with three levels of zinc (0, 2, 4 kg ha^{-1}) and three levels of boron (0, 1, 2 kg ha^{-1}). Same treatments and other fertilizers were used for both foliage and seed production. The experiment was conducted in a randomized complete block design (RCBD) with three replications. Among the various treatments, Zn_4B_1 produced the highest foliage yield (4.47 t ha^{-1}) while Zn_2B_2 produced highest seed yield (1.73 t ha^{-1}). Highest zinc and boron contents were found from Zn_4B_2 incase of both foliage and seeds. Highest Zn and B uptake of foliage were found from Zn_4B_1 and Zn_4B_2, respectively. However, Zn_4B_1 treatment was found better for foliage production and Zn_2B_2 was better for seed production of coriander.

Determination of critical limit of zinc for lentil

A pot experiment on lentil was conducted in the net house of Soil Science Division, Bangladesh Agricultural Research Institute during rabi season of 2019-2020 to determine the critical limit of zinc in soils. The test crop, lentil was grown in twenty soils collected from six AEZs such as Tista Meander Floodplain (AEZ-3), Karatoya-Bangali Floodplain (AEZ-4), Young Brahmaputra and Jamuna Floodplain (AEZ-8), High Ganges River Floodplain (AEZ-11), Low Ganges River Floodplain (AEZ-12) and Madhupur Tract (AEZ-28). The soils contained pH 5.91-8.37, organic matter 0.27-1.67%. The available Zn content was determined by 0.005 M DTPA (Diethylene Triamine Penta Acetic Acid) extraction method. The DTPA extractable Zn in different soils ranged from 0.49-4.20 ppm. The soil available Zn was negatively correlated with soil pH, Ca, Mg and positively correlated with OM, K, dry matter yield. However, the point bellows which lentil showed zinc deficiency in soils was 0.64 ppm (previous year it was 0.56 ppm) which can be expressed as 0.6 ppm as determined by Cate and Nelson's graphical procedure.

Effect of boron on the yield and nutrient uptake of mungbean

An experiment was carried out in Tista Meander Floodplain Soil (AEZ-3) at On Farm Research

Division, Rangpur during Kharif 1 season during 2019-2020. The objectives were to study the effect of boron on yield and nutrient uptake of mungbean (BARI Mung 8), to estimate the optimum dose of boron for higher yield of mungbean (BARI Mung 8) and to find out boron use efficiency of mungbean (BARI Mung 8). The experiment was designed in Randomized Complete Block Design (RCBD) with three replications. BARI Mung 8 with five levels of boron along with a blanket dose $N_{18}P_{18}K_{24}S_{12}Zn_2Mo_{0.8}$ kg $ha^{-1}$was used in the study. BARI Mung 8 produced the highest yield (1.43 t ha^{-1}) for the application of 1.5 kg B ha^{-1}as compared to the other treatments. The lowest yield was found in B_0 treatment where boron was not applied.

Effect of boron fertilization on lentil in Barishal region

A field experiment was conducted at Regional Agricultural Research Station, Rahmatpur, Barishal during November 2019 to February 2020 to find out the optimum dose of boron for lentil in Barishal region. The crop variety was BARI Masur-8. There were five treatments viz. T_0: 0.0 kg B/ha, T_1: 1.0 kg B/ha, T_2: 1.5 kg B/ha, T_3: 2.0 kg B/ha, and $T_{4:}$ 2.5 kg B/ha with four replications. Boron had influence on plant height (cm), shoot and root dry weight, no of pod/plant, seed yield and stover yield of BARI Masur-8. The highest seed yield (1.88 t ha^{-1}) was observed in $T_3B_{1.5}$ which was statistically identical to rest of the treatments in Barishal region. Thus boron @ 1.5 kg ha^{-1} found to be the optimum dose for the cultivation of lentil in greater Barishal region under Non–Calcareous Grey Floodplain Soils (AEZ 13).

Microbiological Aspects of Soil Management

Assessment of arbuscular mycorrhizal association in some field crops

Rhizosphere soils including fine roots of some field crops were collected from Godagari, Rajshahi during 2019-2020 for counting Arbuscular Mycorrhiza (AM) spore population and determining colonization (%) in their roots. The spore numbers of 100-gram rhizosphere soil ranged from 65.00 (Red Amaranth) to a maximum of 230.0 (Pigeon pea). A considerable variation was observed in average spore numbers recorded in different field crops. Among the field crops, the highest root colonization (40.0%) was found in onion and lower colonization (10.0%) was found in rest of the crops under this study.

Study on *Rhizobium*, *Azotobacter* and phosphate solubilizing bacterial (PSB) population status in soils of different AEZs of Bangladesh

Soil microbes play a major role in legumes to supply nutrient to plants as well as decomposition of organic materials and cycling of nutrients. Fourteen soil samples were collected from selected locations of different AEZs of Bangladesh to know the Rhizobium, Azotobacter and Phosphate solubilizing bacterial population at different AEZs of Bangladesh. Soil samples were collected from BARI Central Farm, Gazipur (AEZ-28); BRRI, Habiganj (AEZ-23); Codda, Gazipur (AEZ-28); Saint Martin (AEZ-24); Godagari, Rajshahi (AEZ-26), Lebukhali, Patuakhali (AEZ-13); Batiaghata, Khulna (AEZ-13); OFRD, Gopalgonj (AEZ-19), OFRD, Narsingdi (AEZ-09), Badolgachi, Naogaon (AEZ-06), Gomostapuur, Chapainawabganj(AEZ-06), Akhaura, B. Baria (AEZ-30), Kasba, B. Baria (AEZ-30) and Shreemongal, Moulabibaza (AEZ-29). Rhizobium was grown in media and Rhizobium colonies were counted. The highest Rhizobium (1.2×10^6 g^{-1} soil) was found in soils of Godagari, Rajshahi (AEZ-26) and the lowest population (1.5×10^2 g^{-1} soil) was observed in soils of Batiaghata, Khulna (AEZ-13). Azotobacter was grown in N free media and Azotobacter colonies were counted. The highest Azotobacter population (7.0×10^6 g^{-1} soil) was found in soils of Godagari, Rajshahi (AEZ-26) and the lowest population (3.5×10^3 g^{-1} soil) was observed in BRRI, Hobigonj (AEZ-23). Phosphate solubilizing bacteria was grown in Pikovskaya's media and PSB colonies were counted. The highest PSB population (8.5×10^6 g^{-1} soil) was found in soils of Godagari, Rajshahi (AEZ-26) and the lowest population (1.5×10^4 g^{-1} soil) was observed in Gazipur (AEZ-28).

Effect of azotobacter on the growth and yield of onion

An experiment was carried out during Rabi season of 2019-2020 in the research field of Soil Science

Division, BARI, Joydebpur, Gazipur to find out the effect of Azotobacter inoculum along with different doses of N fertilizer on the growth and yield of onion. The experiment was laid out in RCBD with 6 treatments and 4 replications. Onion (BARI piaj-4) was used as a test crop. Liquid azotobacter inoculum was used in this experiment. The population density of used inoculum was more than 10^8 cell ml^{-1} liquid inoculant. There were six treatments viz. T_1: 100% N of Recommended Dose, T_2: 90% N + Azotobacter inoculum, T_3: 80% N + Azotobacter inoculum, T_4: 70% N + Azotobacter inoculum, T_5: Azotobacter inoculum and T_6: Control. The highest bulb yield (23.75 t ha^{-1}) found in T_3 treatments which was statistically identical with T_1 (22.18 t ha^{-1}) and T_2 (23.60 t ha^{-1}) treatment. This result suggested that use of azotobacter inoculum in combination with reduced dose of N fertilizer was beneficial for onion in Grey Terrace soils of Gazipur (AEZ 28) and thus 20% N fertilizer may be reduced. The experiment should be continued for the confirmation of the findings.

Response of lentil varieties to elite strains of *Rhizobium*

A study was conducted in the research field of Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during 2019-2020 to observe the effect of Rhizobium inoculation with different varieties of BARI released lentil. Four varieties of lentil viz. BARI Masur-6, BARI Masur-7, BARI Masur-8 and BARI Masur-9 and rhizobial inoculum (Rhizobium strain RLc-104) were used in this experiment. Unit plot size was 4 m x 3 m. The experiment was designed in randomized complete block having 3 replications for each treatment. Each variety was tested with/without Rhizobium inoculation. Inoculated plants gave significantly higher nodule number, nodule weight, shoot weight and seed yield compared to non-inoculated plants. Among 4 varieties, BARI Masur-8 produced the highest nodule number and nodule weight. The highest seed yield (1.01 t ha^{-1}) was recorded with BARI Masur-7.The interaction effect revealed that the highest seed yield of 1.10 t $ha^{-1}$was recorded by inoculated BARI Masur-7 in the Grey Terrace soils Gazipur (AEZ-28) . The experiment will be continued for the confirmation of results.

Effect of arbuscular mycorrhizal fungi and phosphorus on cauliflower

A field experiment was conducted in the Central Research Farm, Soil Science Division, Bangladesh Agricultural Research Institute, during rabi season of 2019-2020 to study the effect of combined use of arbuscular mycorrhizal fungi and phosphorus on growth and yield of cauliflower, and to reduce the use of P-fertilizer under field condition. The experiment was designed in RCBD with six treatments and four replications. The cauliflower variety was snow white as a 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 cauliflower seedlings. 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 significantly increased collar diameter (mm), root dry weight (g), root length (cm), root colonization (%), spore population (100 g^{-1} soil) and curd yield (t ha^{-1}). Plant height (cm), Plant weight (kg), unfolded leaf ($plant^{-1}$), curd height (cm) and curd circumstances (cm) were non-significant. The plant that received AM in nursery bed produced higher curd yield than without AM in all phosphorus levels of cauliflower. The highest curd yield (43.2 t ha^{-1}, 52.7% higher over control) was recorded in 50% P with AM (AM was used in nursery bed) in Grey Terrace soils of Gazipur (AEZ 28). The result indicates that the inoculation of AM used in nursery bed may save 50% P fertilizer in the field. The plant which did not receive AM in nursery bed produced lower yield irrespective of phosphorus levels in the field.

Effect of biofertilizer, vermicompost and chemical fertilizers on cowpea

A field experiment was conducted in the research farm of Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute, Hathazari, Chattogram during rabi season of 2019-2020 to evaluate the effect of Rhizobium biofertilizer, vermicompost and chemical fertilizers on cowpea. The crop variety was cowpea (BARI Fellon-1) and Rhizobium strain was BARI RVu-602. 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} + Rhizobium + IPNS based PKSZnB, T_7: VC @ 5 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. Rhizobium inoculated cowpea with vermicompost @ 5 t ha^{-1} and IPNS based PKSZnB increased nodule number (21.8 plant^{-1}), nodule weight (0.26 g plant^{-1}), root weight (0.63 g plant^{-1}), shoot weight (6.23 g plant^{-1}) and plant height (56.3 cm). It was observed that the same treatment produced the highest seed yield (1.46 t ha^{-1}, 82.5% higher over control) of cowpea which differed with all other treatments except $T_{4,}$ T_5 and T_6. This indicates that the application of vermicompost @ 5.0 t ha^{-1} plus Rhizobium inoculant may reduce a considerable amount of chemical fertilizers. Vermicompost exhibited better performance in cowpea. Therefore, vermicompost @ 5 t ha^{-1} plus Rhizobium inoculant along with IPNS based chemical fertilizers except N may be recommended for cowpea cultivation in Chattogram Coastal flood plain soil (AEZ 23).

Salt tolerant bacterial performance on groundnut in saline prone coastal region of Bangladesh

A field experiment was carried out at On Farm Research Division, Bangladesh Agricultural Research Institute, Cox's Bazar and Noakhali during rabi season of 2019-2020 to study the nodulation capacity of salt tolerant rhizobial strains and their performance on growth and yield of groundnut under field condition. Seeds were shown on 23 December 2019 and 29 December 2019 in Cox's Bazar and Noakhali, respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were 12 treatments viz. T_1: Rhizobium GR1, T_2: Rhizobium GR2, T_3: Rhizobium GR3, T_4: Rhizobium GR4, T_5: Rhizobium GR5, T_6: Rhizobium GR6, T_7: Rhizobium GR7, T_8: Rhizobium GR8, T_9: Rhizobium GR9, T_{10}: Rhizobium GR10, T_{11}: Rhizobium BARI RAh 801 and T_{12}: Control. The tested crop was groundnut (cv. BARI Chinabadam-8). Peat based rhizobial inoculum containing 10^8 cells g^{-1} and inoculum was used at the rate of 1.5 kg ha^{-1}. Seeds were mixed thoroughly with inoculum (20:1 ratio) before sowing. Seeds were used at the rate of 75 kg ha^{-1}. Application of salt tolerant Rhizobium biofertilizer on groundnut, exhibited better performance in nodule numbers, nodule weights, above ground biomass, root biomass, and plant height than non-inoculated plants, indicating that all Rhizobium sp. effectively enhanced nodulation and growth parameters on groundnut plant than non-inoculated plants. Plants inoculated with Rhizobium sp. showed the higher pod yield, stover yield and seed yield than non-inoculated plants, revealing the positive impact of Rhizobium sp. on yield parameters of groundnut in saline area. Groundnut plants inoculated with Rhizobium sp.GR9 showed the highest nut yield of 2.82 t ha^{-1} at Cox's Bazar under Chattogram Coastal Plain (AEZ 23) and 2.84 t ha^{-1} at Noakhali under Lower Meghna River Flood Plain (AEZ 17).

Performance of salt tolerant bacterial inoculum on soybean in saline prone coastal region of Bangladesh

A field experiment was carried out at On Farm Research Division, Bangladesh Agricultural Research Institute, Cox's Bazar and Noakhali during the rabi season of 2019-2020 to study the nodulation capacity of salt tolerant rhizobial strains and their performance on growth and yield of soybean under field condition. Seeds were shown on 20 January 2020 and 24 January 2020 in Cox's Bazar and Noakhali, respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were 12 treatments viz. T_1: Rhizobium SR1, T_2: Rhizobium SR2, T_3: Rhizobium SR3, T_4: Rhizobium SR4, T_5: Rhizobium SR5, T_6: Rhizobium SR6, T_7: Rhizobium SR7, T_8: Rhizobium SR8, T_9: Rhizobium SR9, T_{10}: Rhizobium SR10, T_{11}: Rhizobium BARI RGm-901and T_{12}: Control. The tested crop was Soybean (cv. BARI Soybean-5). Peat based rhizobial inoculum containing 10^8 cells g^{-1} and inoculum was used at the rate of 1.5 kg ha^{-1}. Seeds were mixed thoroughly with inoculum (20:1 ratio) before sowing. Seeds were used at the rate of 75 kg ha^{-1}.

Application of salt tolerant Rhizobium biofertilizer on soybean, exhibited better performance in nodule numbers, nodule weights, above ground biomass, root biomass, and plant height than non-inoculated plants, indicating that all Rhizobium sp. effectively enhanced nodulation and growth parameters of soybean plant than non-inoculated ones. Plants inoculated with Rhizobium sp. showed higher pod yield, stover yield and seed yield than non-inoculated plants, revealing the positive impact of Rhizobium sp. on yield parameters of Soybean in saline area. Soybean plants inoculated with Rhizobium sp., SR7 showed the highest seed yield (1.97 t ha^{-1}) at Cox's Bazar under Chattogram Coastal Plain (AEZ 23) and also at Noakhali (2.08 t ha^{-1}) under Lower Meghna River Flood Plain (AEZ 17) than other strains.

Effect of *Trichoderma harzianum* and Arbuscular mycorrhizal fungi on growth and disease incidence in groundnut (*Arachis hypogaea*)

A study was carried out to evaluate the effect of indigenous Arbuscular Mycorrhizal Fungi (AMF) and Trichoderma harzianum on germination, nodulation, colonization and yield of groundnut along with their biocontrol ability against groundnut foot and root rot caused by *Sclerotium rolfsii*. The bio-control potential of these bio-agents against foot and root rot pathogen was carried out under pot culture condition using arbuscular mycorrhizal fungi (AMF) alone or in combination with Trichoderma harzianum in the nethouse of Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur during 2019 and 2020. The experiment was designed in CRD with eight treatments and four replications. The result showed that dual inoculation (AMF+Trichoderma) produced the highest germination, nodulation, colonization and yield of groundnut compared to control or single inoculation. In contrary, *Sclerotium*+AMF+Trichoderma treatment produced significantly higher germination, nodulation, colonization and yield of groundnut compared to single inoculation with *Sclerotium*. Dual inoculation (AMF+Trichoderma) increased germination (14.00% in 2019 and 10.86% in 2020) after 20 days after sowing, nut yield (5.25% in 2019 and 23.32% in 2020) and stover yield (24.40% in 2019 and 41.43% in 2020) compared to control. On the other hand, Sclerotium rolfsii+AMF+Trichoderma increased germination (30.31% in 2019 and 43.77% in 2020) after 20 days of sowing, nut yield (56.80% in 2019 and 26.67% in 2020) and stover yield (25.08% in 2019 and 36.60% in 2020) compared to only *Sclerotium rolfsii* trearment. These bio-control agents proved not only both effective and safe under organic mode but also for ensuring biological control, better growth and improved productivity of this important oil crop of Bangladesh.

Biocontrol of foot and root rot disease of groundnut (*Arachis hypogaea*) by dual inoculation with *Rhizobium* and Arbuscular mycorrhiza

The present study was carried out to investigate the potentiality of AM (Arbuscular mycorrhiza) fungi alone and in combination with Rhizobium on germination, dry biomass, nodulation, colonization and yield, along with their biocontrol ability against groundnut foot and root rot caused by *Sclerotium rolfsii*. The study was carried out under pot culture condition in the net house of Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur in during 2018-2019 and 2019-2020.. The experiment was conducted in RCBD with eight treatments and four replications. Peat based rhizobial inoculum (BARI RAh-801) was used in this experiment. Soil based AM inoculum containing about approximate 252 ± 20 spores and infected root pieces of the host plant was used pot^{-1}. The treatments were Arbuscular mycorrhiza (AM), Rhizobium, AM+Rhizobium, *Sclerotium rolfsii*, *Sclerotium rolfsii*+AM, *Sclerotium rolfsii*+Rhizobium, *Sclerotium rolfsii*+AM+Rhizobium and Control. Dual inoculation (AM+Rhizobium) significantly increased germination (%), dry biomass, nodulation, colonization, yield and yield attributes of groundnut compared to single inoculation or any other treatments. The result showed that dual inoculation (AMF+Rhizobium) increased 59.61% nut yield and 37.81% stover yield compared to control. In contrary, *Sclerotium rolfsii*+AMF+Rhizobium increased 65.50% nut yield and 36.45% stover yield compared to only *Sclerotium rolfsii* trearment. AMF species and their combination with rhizobial inoculum were significant both in the formation and effectiveness of AM symbiosis and the reduction of foot and root rot incidence in groundnut plants.

Effect of Arbuscular mycorrhizal inoculation on groundnut at different salinity levels

A pot experiment was carried out in the net house of Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur during 2019-2020. The objectives of the study were to evaluate the potentiality of arbuscular mycorrhizal inoculation on the germination, fresh and dry biomass, nodulation, colonization and yield of groundnut treated with different salinity levels. The experiment was conducted in a factorial completely randomized design (CRD) with four replications. Five salinity treatments (0, 2, 4, 6 and 8 dSm^{-1}) were imposed to either mycorrhizal or non-mycorrhizal treatments. Soil based mixed arbuscular mycorrhizal (AM) inoculum containing about approximate 252 ± 20 spores and infected root pieces of the host plant was used pot^{-1}. With increasing salinity concentration germination (%), nodulation, colonization, biomass, plant height, nut yield and stover yield decreased significantly. It was observed that 0 dSm^{-1} + AM treatment produced the highest nut yield (16.93 g $plant^{-1}$) and stover yield (19.17 g $plant^{-1}$) of groundnut. In contrast, 8 dSm^{-1} treatments produced the lowest nut yield (12.52 g $plant^{-1}$) and stover yield (14.47 g $plant^{-1}$) of groundnut. The study clearly indicates that mycorrhizal inoculation could reduce the harmful effects of salinity to the host plants, thus may increase plant survival allowing the plants growth under salt stressed condition.

Effect of arbuscular mycorrhizal fungi, biochar and vermicompost on soybean (*Glysine max*) in saline soil

The present study was carried out to evaluate the effect of indigenous Arbuscular Mycorrhizal Fungi (AMF), biochar and vermicompost on nodulation, colonization and yield character of soybean with 8 dS m^{-1} saline soil. The experiment was carried out under pot culture condition in the nethouse of Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur during 2018-2019 and 2019-2020. The experiment was designed in CRD with eight treatments and four replications. The ten treatments were T_1 : Control, T_2 : Arbuscular mycorrhiza (AM), T_3 : Biochar @10 t ha^{-1}, T_4 : Vermicompost@ 3 t ha^{-1},T_5 : AM + Biochar @ 5 t ha^{-1}, T_6 : AM + Biochar @ 10 t ha^{-1}, T_7 : AM + Vermicompost @ 3 t ha^{-1}, T_8 : AM + Vermicompost @ 6 t ha^{-1}, T_9 : Biochar @ 5 t ha^{-1} + Vermicompost @ 3 t ha^{-1} and T_{10} : AM + Biochar @ 5 t ha^{-1} + Vermicompost @ 3 t ha^{-1}. The result showed that AM + Biochar @ 5 t ha^{-1} + Vermicompost @ 3 t ha^{-1} treatment produced the highest nodulation, colonization and yield character of soybean under 8 dS m^{-1} saline soil condition and control treatment produced lower nodulation, colonization and yield character of soybean in saline soil. AM + Biochar @ 5 t ha^{-1} + Vermicompost @ 3 t ha^{-1} treatment (T_{10}) produced 3.03%, 25.65%, 16.30% and 164% higher seed yield in 2018-2019 and 10.00%, 16.38%, 5.90% and 35.86% higher seed yield in 2019-2020 compared to T_9 (Biochar @ 5 t ha^{-1} + Vermicompost @ 3 t ha^{-1}), T_7 (AM + Vermicompost @ 3 t ha^{-1}), T_5 (AM + Biochar @ 5 t ha^{-1}) and T_1 (Control) treatment. On the other hand, T_{10} treatment produced 1.52%, 18.73%, 10.87% and 66.90% higher stover yield in 2018-2019 and 7.49%, 14.86%, 12.29% and 48.89% higher stover yield in 2019-2020 compared to T_9, T_7, T_5 and T_1 treatment.

Effect of biofertilizer and chemical fertilizers on soil microabial population status, nodulation pattern, nodule initiation and yield of chickpea varieties

A field experiment was conducted in the Central Research Farm of Bangladesh Agricultural Research Institute (AEZ-28) and Regional Agricultural Research Station (RARS), Jamalpur (AEZ-09) during rabi season 2019-2020 to evaluate the effects of biofertilizer and chemical fertilizer on soil microabial population, nodulation pattern, nodule initiation and yield of pulse crops. The experiment was laid out in randomized complete block design (RCBD) with 2 factors (fertilizer doses and varieties) having 3 replications. Three fertilizer doses were 100% PKSZnB, Rhizobium + 100% PKSZnB, 100% NPKSZnB and three varieties were BARI chola-5, BARI chola-9 and BARI chola-10. Unit plot size was 3 m x 2 m.

Basal dose of fertilizer was 50-22-42-20-5-1 kg N-P-K-S-Zn-B ha^{-1}. All the fertilizers except N were applied as basal at final land preparation. N was applied in three equal splits at 10, 20 and 30 days after sowing. Peat based rhizobial inoculum (BARI RCa-259) @ 1.5 kg ha^{-1} was used for seed inoculation for the said treatment. Rhizobium bacteria contained about 10^8 cells g^{-1} inoculum. BARI chola-10 showed the greater ability to produce maximum number of nodule than all other varieties. Chickpea varieties required 18 to 20 days for their first nodulation. The nodulation pattern trend was BARI chola-10> BARI chola-5> BARI chola-9 in both locations. Among three varieties, nodule initiation was increased during pre-flowering stage but decreased when it turns into reproductive stages. The better nodulation was observed after 49 days of nodule initiation. Rhizobium + 100% PKSZnB performed better than any other fertilizer doses at both locations. Regarding variety, BARI chola-10 gave better results than othersInteraction effect of fertilizer doses and varieties, the treatment Rhizobium + 100% PKSZnB with BARI chola-10 and 100% NPKSZnB with BARI chola-10 significantly gave the highest straw yield and seed yield in Gazipur and Jamalpur, respectively. In case of microbial population status, Rhizobium + 100%PKSZnB treated plots showed the maximum number of populations in both locations. The study will be continued in the next year to confirm the findings.

22 ENTOMOLOGY

Integrated pest management

Evaluation of different management packages against flower thrips and pod borers of mungbean

The experiment was conducted in the experimental field of Entomology division, BARI, Gazipur during Kharif-I, 2020. Treatments were T_1 = IPM Package 1: installing blue sticky trap + two sprays of Matrine (Biotrin 0.5%) @ 1.4 ml/L of water (first spray at flower initiation stage and second one at peak flowering stage) + third spraying with Spinosad (Success 2.5 SC) @ 1.2 ml/L of water at seed developing stage (7 days after second spray); T_2 = IPM Package 2: Installing blue sticky trap + spraying Bio-chamak (*Celastrus angulatas* 1%EW) @ 2.5 ml/L of water (first spray at flower initiation stage and second one at peak flowering stage) + third spraying with Spinosad (Success 2.5 SC) @ 1.2 ml/L of water at seed developing stage (7 days after second spray); T_3 = IPM Package 3: Installing blue sticky trap + two sprays of Chlorfenapyr (Intrepid 10 SC @ 1ml/L water (first spray at flower initiation stage and second one at peak flowering stage) + third spraying with Emamectin Benzoate (Proclaim 5 SG) @ 1g/L of water at seed developing stage (7 days after second spray); T_4 = Farmers' practice: Three sprayings of Imidacloprid (Imitaf 20SL) @ 0.5ml/L of water at 7 days interval starting from flower initiation stage; and T_5 = Untreated control. The population data for thrips in flowers were collected at weekly interval starting from flowering. Thrips population was assessed from 20 opened flowers randomly collected from two rows from each side of the plot avoiding border and central four rows. The collected flowers were immediately opened carefully on the white paper board and the adult and pre-adult thrips present in the flowers were counted. Central four rows were kept undisturbed for recording yield data. Thrips population was significantly reduced after two sprayings with Intrepid 10 SC @ 1ml/L water at flower initiation stage and peak flowering stage. Pod infestation by borer was lower in IPM package 2 (3.09%) which resulted the highest yield (1.19 t/ha), followed by T_4 treatment i.e. spraying of imidacloprid (Imitaf 20SL) @ 0.5ml/L of water at 7 days interval starting from flower initiation stage.

Evaluation of several management packages against pod borer, *Helicoverpa armigera* infesting chickpea

The experiment was conducted in the research field of Entomology division, BARI, Gazipur, during rabi 2019-2020 to evaluate different IPM packages against pod borer, *Helicoverpa armigera* attacking chickpea. The variety BARI Chola-9 was used in this study. The treatments were: T_1 = Pheromone mass trapping (BARI water trap) + spraying of spinosad (success 2.5 SC) @ 1.2ml/ litre of water; T_2 = Pheromone mass trapping (Moth Catcher-1) + spraying of spinosad (success 2.5 SC) @ 1.2ml/ litre of water; T_3 = Pheromone mass trapping (Moth Catcher-2) + spraying of spinosad (success 2.5 SC) @ 1.2ml/ litre of water; T_4 = Pheromone mass trapping (BARI water trap) + spraying of *Celastrus angulatas* (Bio-chamak 1% EW) @ 2.5ml/ litre of water; T_5 = Farmers' practice: Spraying of Nitro 505EC (cypermethrin + chlorpyriphos) @ 2ml/litre of water; & T_6= Untreated control. Results indicated that the lowest percent of pod damage (3.90%) and the highest yield (1.47 t/ha) was recorded from sex pheromone mass trapping (BARI water trap) + spraying of *Celastras angulatas* (Bio-chamak 1% EW) @ 2.5 ml/ litre of water, followed by sex pheromone mass trapping (Moth Catcher-1) + spraying of spinosad 2.5 SC @1.2 ml/ litre of water.

Comparative evaluation of different IPM packages against major insect pests of brinjal

The experiment was carried out in the Entomology research field of BARI, Gazipur during 2019-20 for evaluating different bio-rational based management approaches against major insect pests of brinjal. The experiment was laid out in RCB design with three dispersed replications. There were five treatments including control. The treatments were: T_1= IPM package-1: Mechanical control + D-lemonine (Bio-clean 5% SL) @ 1 ml/liter of water + Sex pheromone trapping + spinosad (Success 2.5SC) @ 1.2 ml/litre of water; T_2= IPM package-2: Mechanical control + Matrine (Biotrin 0.5%) @ 1.4 ml/L of water + Sex pheromone trapping + spinosad (Success 2.5SC) @ 1.2 ml/litre of water; T_3= IPM package-3: Mechanical control + *Celastrus angulatas* (Bio-chamak 1%EW) @ 1ml/L of water + Sex pheromone trapping + Matrine (Biotrin 0.5%) @ 1.4ml/L of water; T_4= IPM package-4: Mechanical control + afidopyropen 5% (Sefina 5DC @ 2ml/l of water) + Sex pheromone trapping + spinosad (Success 2.5SC) @ 1.2 ml/litre of water; T_5= Farmers practice: weekly spraying of chlorantraniliprole + thiamethoxam (Voliam flexi 300SC) @ 0.5ml/litre of water; and & T_6 = Untreated control. The results indicated that, IPM package-3: Mechanical control + *Celastrus angulatas* (Bio-chamak 1%EW) @ 1ml/L of water) + Sex pheromone trapping + Matrine (Biotrin 0.5%) @ 1.4ml/L of water was the most effective against major insect pests of brinjal. Significantly the lowest pest populations were observed in all the IPM packages than the farmers' practice. The lowest fruit infestation was found in the IPM package 3 (7.94%). The highest yield was recorded in the IPM package 4 (28.07 t/ha) treated plots followed by IPM package 3 (27.80 t/ha). The highest net return (244850/- Tk. /ha) and marginal benefit cost ratio (8.34) was obtained from IPM package 3.

Development of management approach against sucking insect pests of brinjal

The experiment was conducted in the research field of BARI, Gazipur during 2019-20 to evaluate several management approaches against sucking pests of brinjal. The treatments were assigned as follows: T_1= Matrine (Biotrin 0.5% @ 1.4 ml/L of water) + Blue & yellow sticky traps; T_2= Sodium lauryl ether sulphate (Fizimite 10% @1ml/L of water) + blue & yellow sticky traps; T_3= Bio-clean (D-Lemonine 5% SL) @ 1ml/L of water + blue & yellow sticky traps; T_4= Diafenthiuron (Pegasus 500SC @ 1ml/L of water) + blue & yellow sticky traps; T_5= Afidopyropen (Sefina 5 DC @ 2ml/l of water) + blue & yellow sticky traps; T_6 = Farmers' practice: spraying with Thiamethoxam (Actara 25 WG @ 0.2g/L of water); and T_7 = Untreated control. The observations on counts of sucking pests viz., aphid, jassid, thrips and whitefly were recorded on five randomly selected plants per treatment. On each plant, five leaves (one from bottom and two each from middle and top portion of the plant) were observed from lower side to record the pest count. The data on surviving population were reported on the basis of mean insect population/five leaves. Percent (%) insect pest population reduction over untreated control was calculated. Yield under different treatments were recorded at each harvest and yield (t/ha) was calculated. Benefit cost ratios of different treatments were also determined. Result revealed that all the treatments significantly reduced aphid, jassid and whitefly population in brinjal. A new generation green pesticide, Afidopyropen (Sefina 5 DC) sprayed @ 2ml/l of water + blue & yellow sticky traps treated plots showed significantly lowest aphid (2.33/five leaves), jassid (3.13/five leaves) and whitefly (1.33/five leaves) population. The bio-pesticide treatments also performed better to manage those sucking pest of brinjal. However, installation of blue and yellow and sticky traps in combination with spraying Afidopyropen (Sefina 5 DC) @ 2ml/L of water appeared as the best approach providing highest yield (18.32 t/ha) and MBCR (5.66).

Development of bio-rational management approach against major insect pests attacking country bean

A field experiment was undertaken at research field of Entomology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur during rabi 2019 cropping season to evaluate several management options against major insect pests attacking country bean. The experiment was laid out in randomized block design with five treatments and four replications. The treatments were as follows: T_1= Matrine (Biotrin 0.5%) @ 1 ml/L of water+ alternate spray of MNPV@ 1g/L of water and spinosad (Success 2.5 SC) @ 1.2ml/L of water; T_2= Bioclean (D-Limonine) @ 1 ml/L of water + alternate spray of MNPV@ 1g/L of water and Antario @ 0.5g/L of water; T_3= Fizimite @ 1ml/L of water +alternate spray of MNPV @ 1g/L of water and Antario @ 0.5g/L of water; T_4= Alternate spray of spinosad (Success 2.5 SC) @

1.2ml/L of water and Imidacloprid (Imitaf 20SL) @ 0.5ml/L of water; and T_5= Untreated control. Results indicated that, management package comprising of spraying Bioclean (D-Limonine) @ 1 ml/L of water + alternate spray of MNPV @ 1g/L of water and Antario @ 0.5g/L of water offered significantly the lowest thrips population (4.38/inflorescence) and lowest pod infestation by borer (1.11%). Significantly the highest yield (15.76 t/ha) was also obtained from this package.

Sustainable management approach against thrips-mite and borer complex in chilli

An experiment was carried out during 2019-2020 in the Entomology research field of BARI, Gazipur to find out suitable management approach against thrips-mite and borer complex of chilli. The treatments were assigned as follows: T_1= Blue sticky trap + Spraying of Matrine (Biotrin 0.5% @ 1.4 ml/L of water) + Pheromone trapping + Fizimite @ 1 ml/L of water; T_2 = Spraying of K-mite @ 1ml/L of water + application of soil recharge @ 3 gm/L of water + Pheromone trapping + Application of HNPV & SNPV during visible borer infestation; T_3 = Spraying of Abamectin (Ecomec 1.8 EC) + Pheromone trapping + Application of HNPV & SNPV during visible borer infestation; T_4 = Spraying Chlorphenapyr (Intrepid 10EC) @ 1ml/L of water + Abamectin (Ecomec 1.8 EC) @ 1ml/L of water; and T_5 = Untreated control. The management approach (T_4) comprising of spraying of Chlorphenapyr (Intrepid 10 SC) @ 1 ml/L of water + Abamectin (Ecomec 1.8 EC) @ 1 ml/L of water appeared as the best management option against thrips-mite and borer complex recording the lowest thrips population (3.00/twig) and mite population (0.29/leaf), although these were statistically identical to T_3 i.e. spraying of Abamectin (Ecomec 1.8 EC) @ 1 ml/L of water + Pheromone trapping + application of HNPV & SNPV. The highest yield (12.89 t/ha) and marginal benefit cost ratio (MBCR) (3.1) was also achieved from T_4 treatment.

Pesticide toxicology

Determination of pre harvest intervals for lambda-cyhalothrin and fenitrothion in major vegetables

The study was carried out to determine the pre harvest interval (PHI) for lambda-cyhalothrin in yard long bean and fenitrothion in cauliflower, hyacinth bean and tomato depending on Maximum Residue Limit (MRL) set by European Union. Four supervised field trials were conducted where respective vegetables were sprayed with recommended doses of fenitrothion @ 2 ml/L of water and lambda-cyhalothrin @ 1 ml/L of water. Samples were collected at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 days after spray (DAS). The lambda-cyhalothrin residue was detected up to 10 DAS in yard long bean and the quantities were above MRL up to 7 DAS. No residue was detected at 11 DAS in yard long bean. In case of fenitrothion, the quantities were above EU-MRLs up to 8 DAS (2.986-0.034 mg/kg) in tomato, 10 DAS (3.782 - 0.018 mg/kg) in hyacinth bean and 11 DAS (5.831-0.021 mg/kg) in cauliflower. The PHI was determined at 8 DAS for lambda-cyhalothrin in yard long bean, and for fenitrothion it was 9 DAS in tomato, 11 DAS in hyacinth bean and 12 DAS in cauliflower.

Determination of pesticide residue load in major vegetables collected from different regions of Bangladesh

The study was conducted to detect and quantify the left over residues of seven commonly used organophosphorus pesticides (chlorpyrifos, quinalphos, diazinon, acephate, fenitrothion, malathion and dimethoate) in three vegetables like hyacinth bean, cauliflower and brinjal collected from local markets of four different locations viz. Rajshahi, Jamalpur, Dhaka and Gazipur. The detected residue levels were compared with maximum residue limit (MRL) set by European Union (EU). A total of 130 samples of brinjal, cauliflower and hyacinth bean were collected from Rajshahi, Jamalpur, Dhaka and Gazipur and were analyzed for the quantification of pesticide residues. Among them, 20 samples (about 15%) were contaminated with the residues of dimethoate, chlorpyrifos, quinalphos, acephate, fenitrothion and diazinon. Out of 20 contaminated samples, 17 samples (about 13% of the total number of samples) of brinjal, cauliflower and hyacinth bean contained residues which were above respective MRL. Among 42 analyzed samples of brinjal, 12% samples were contaminated with chlorpyrifos, quinalphos and dimethoate residues which were above MRL. Among 42 analyzed samples of cauliflower, 6 samples (about 14% of the total number of samples) were contaminated with acephate, diazinon, quinalphos, chlorpyrifos and dimethoate residues which were above MRL. Out of 46 analyzed samples of bean, 13% samples were contaminated with chlorpyriphos, quinalphos, fenitrothion and dimethoate residues which were above MRL. Sample of cauliflower from Rajshahi showed 31 times higher residue of diazinon (0.316 mg/kg) and 23 times higher residue of acephate (0.231 mg/kg) than the respective MRL. Cauliflower sample collected from Jamalpur also had about 25 times higher residue of quinalphos (0.248 mg/kg) than MRL. Sample of bean collected from Rajshahi had 25 times higher residue of quinalphos (0.254 mg/kg) than respective MRL.

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 Thermionic Detector (FTD) and Electron Capture Detector (ECD) were used for the determination of pesticide residues in 50 samples of mango, 15 samples of litchi, 20 samples of guava and 40 samples of ber. A total of 125 fruit samples were analyzed. Among the 50 analyzed samples of mango, 4 were contaminated with cypermethrin residues. The levels of detected cypermethrin residues (0.011 mg/kg, 0.016 mg/kg, 0.02 mg/kg, and 0.028 mg/kg) were below EU-MRLs; out of 15 analyzed samples of litchi, 1 had cypermethrin residue (0.072 mg/kg), which was below EU-MRLs; among the 20 analyzed samples of guava, 2 contained acephate residues (0.03 mg/kg, and 0.05 mg/kg), both of them were above EU-MRL; out of 40 analyzed samples of ber, 4 were contaminated with pesticide residues, one had chlorpyrifos residue (0.029 mg/kg) and 3 had cypermethrin residues (0.042 mg/kg, 0.070 mg/kg and 0.272 mg/kg). All the contaminated samples of ber contained residues below EU-MRLs. 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 Thermionic Detector (FTD) and Electron Capture Detector (ECD) were used for the determination of 7 organophosphorus insecticides, 3 synthetic pyrethroid insecticides and 2 fungicides residues in the samples of betel leaf collected from different locations of Bangladesh. A total of 55 samples were analyzed. Among the analyzed samples of betel leaf, 5 contained detectable residues of the sought pesticides. Out of 5 contaminated samples, 3 were contaminated with cypermethrin residues (0.179 mg/kg, 2.17 mg/kg and 7.80 mg/kg) and 2 were contaminated with chlorpyrifos residues (0.870 mg/kg and 1.95 mg/kg) with a level above EU-MRLs. This study reflects the present scenario of pesticide residue contamination in betel leaf collected from different locations of Bangladesh.

Determination of multiple pesticide residues in capsicum, green chilli, lettuce leaf and coriander leaf collected from different markets of Bangladesh

The present study was conducted to detect and quantify the level of pesticide residues in capsicum, green chilli, lettuce leaf, and coriander leaf using QuEChERS (Quick, easy, cheap, effective, rugged and safe) extraction and Gas Chromatography coupled with Flame Thermionic detector (GC-FTD) and Electron Capture Detector (GC-ECD). A total of 66 samples were collected from local market of Dhaka, and Gazipur and carried to the Pesticide Analytical Laboratory, Entomology Division, BARI, Gazipur for the quantification of pesticide residues. Among 66 analyzed samples, 10 (around 15 % of the total no. of samples) were contaminated with cypermethrin, dimethoate, quinalphos, acephate and chlorpyrifos residues. Out of 10 contaminated samples, 7 contained residues above EU-MRLs.

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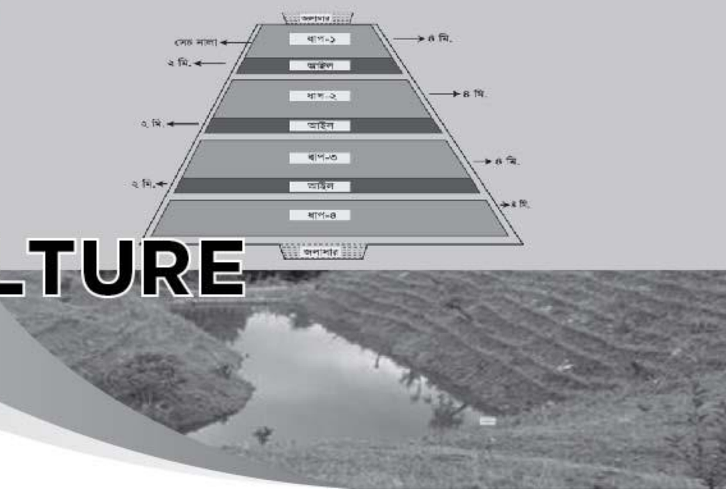


Evaluation of jackfruit germplasm in the hilly region

Evaluation of existing eleven jackfruit germplasm was done at fruit farm of HARS, Khagrachari during the year 2019-20 to identify superior small sized jackfruit germplasm with high yield potentiality and edible qualities. Yield and yield components of the jackfruit germplasm were studied. Number of fruits/plant ranges from 65-117. AH Kha 006 produced the maximum number of fruits (117) and the minimum was recorded in AH Kha 004 (65). Single fruit weight ranged from 2.95-3.90 where AH Kha 003 produces highest (3.90 kg) individual fruit weight and the lowest was found from AH Kha 002 (2.95 kg). TSS content of the fruit varied from 17-27.1 where the highest TSS (27.1%) recorded in AH Kha 010. Yield (kg/plant) showed the highest (442.8 kg) in AH Kha 006 and lowest in AH Kha 004 (166.6Kg). The edible portion was varied from (35.33-52.67) % where AH Kha 005 showed the highest (52.67 %) and the lowest was observed in AH Kha 008 (35.33 %).

Performance of mango (Kanchamitha) germplasm in the hilly region

An experiment was conducted for the evaluation of one Kanchamitha mango germplasm (MI Kha 001) at Hill Agricultural Research Station, Khagrachari during 2019-20. The full blooming period was at the end of January. The tree habit was spreading to intermediate type. Harvesting period was 7 to 11 May, 2020. Total Soluble Solids (TSS) was recorded 9.75%. Edible portionwas found (80.40%). Overall growth conditions of the germplasm were found satisfactory. Considering the fruit characters and edible quality MI Kha 001 was considered as a promising mango for used as unripe condition.

Evaluation of indegenous ber germplasm at Khagrachari

A study was conducted at Hill Agricultural Research Station in Khagrachari hill district with 31 local ber genotypes during 2017 to March 2020. Average individual fruit weight ranged from 6.66 g to 17 g. The genotype ZM Kha 024 produced the highest individual fruit weight (17g) and lowest in ZM Kha 008(6.66g). Fruit weight (12 fruits) of different ber genotypes ranged from 80-204g. The genotype ZM Kha 024 produced the highest fruit weight (204 g) and lowest in ZM Kha 008 (80.0 g). Edible portion (%) ranged from 68.47% (ZM Kha 021) to 92.07% (ZM Kha 026). % TSS of ber genotypes varied from 9.2% (ZM Kha 030) to 18.4% (ZM Kha 017).

Evaluation of sweet orange germplasm in the hilly region

The experiment was conducted to study the performance of sweet orange germplasm collected from different locations of CHT and planted at HARS, Khagrachari. Two germplasm *viz*. CS Kha 001, CS Kha 002 and a check variety BARI Malta-1 were evaluated to identify promising sweet orange germplasm in respect of fruit bearing, fruit quality and yield potentiality. Flowering time ranges from February to March in case of CS Kha 002 and BARI Malta-1 but in case of CS Kha 001 it was March. Harvesting time was late November in case of CS Kha 001. All the germplasm produced profuse plants. No. of fruits/plant was highest (209) in BARI Malta-1 while lowest in CS Kha 002.(87) Individual fruit weight was also varying from 135.33-145.35g. Weight of fruits/plant was highest (27.53 kg) in BARI Malta-1, while CS Kha 001 produced 24.65 Kg/plant and lowest (17.00 kg) in CS Kha 002. Number of seeds ranged from 10-22.

Seed width ranged from 5.1-5.6mm and seed length was ranged from 13.5-13.8. 100 seed weight observed lowest (9.0 g) in CS Kha 001and highest (14.4 g) in BARI Malta-1 where in case of CS Kha 002 it was found 9.1g. TSS ranged from 7.5 to 8.5%.

In situ evaluation of year round pummelo germplasm

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari during the year 2019-20. One off-season pummel germplasms (CGKha001) was selected for the evaluation along with a normal season control. Mainly year round bearing occurred in the germplasm. Maximum numbers of mature (42) and immature (67) fruits were found in the month of Septemberand May respectively. Average fruit weight was 1.35 kg. The maximum edible portion was obtained (50.91%) and the highest TSS (10.4%). The average number of fruits per month (17.67) was collected from CGKha001. Consideration of fruit characteristics, edible quality, TSS, percent edible portion and yield potentialities, the germplasm CGKha001 was found promising.

Evaluation of late-season pummelo germplasm in the hilly region

The study was conducted at the Hill Agricultural Research Station, BARI, Khagrachari during the year 2016-17, 2017-18 and 2018-19. One off-season/late season pummelo germplasm (CG Kha 001) was selected for the evaluation along with a check variety (BARI Batabilebu-5). Mainly late variety, harvesting time December to January. High yielder (107 fruits/plant and 154.1 kg/plant) on 12 year old plant compared to check variety (18.33 fruits/plant and16.04 kg/plant). Fruits of the proposed line are Pyriform shape, large size average individual fruit weight (1450 g) with excellent light yellow colour of rind where check variety produced less (875 g). Pulp was very sweet in taste, soft juicy, light pink in colour, having pleasant aroma and bitterness. Average edible portion was high (67.55%). Average TSS is comparatively high (9.30%) than check variety (9.05%). Fruit retention percentage is very high. Seeds are small in size (weight of 100 seed is 40.44 g). The germplasm (CG Kha 001) was less susceptible to insect-pests and diseases and plant can survive in drought condition.

Characterization and evaluation of turmeric lines

The experiment was conducted at Hill Agricultural Research Station, Khagrachari during May, 2019 to February, 2020. Four turmeric lines were considered for evaluation in RCB design with three replications. The highest leaf length (48.26 cm) was found in CL Kha 006 followed by CL Kha 002 (43.98 cm) which was statisticaly similar to CL Kha 003 (42.92 cm). The highest number of primary fingers /clump (13) and secondary fingers /clump (22.00) was obtained from CL Kha 002 which was statisticaly similar to CL Kha 006. Weight of primary fingers (221.00 g) and mother rhizomes per clump (93.16 g) were highest in CL kha002 and that were statisticaly similar to CL Kha 006. CL Kha 002 possessed the highest finger breadth (2.73 cm) which was statisticaly similar to CL Kha 009 (2.43 cm) followed by CL Kha 003 and CL Kha 006. Weight of secondary finger/ clump (116.73 g) and rhizome yield /clump was highest (430.83 g) in CL Kha 002 followed.

Effect of different standard on growth and yield of black pepper (*P. nigrum*)

The experiment was conducted at Hill Agricultural Research Station, Khagrachari during May, 2019 to February, 2024. Jantia Golmorich was considered for evaluation in RCBD design with three replications. The highest plant was found in *Sesbania grandifolia* (7 feet). Similarly the highest leaf width was found 6.33cm in *Sesbania grandifolia*. The highest internodes length (6.5cm) was found in Iron standard surrounding by half inch iron meshnet.

Performance evaluation of BARI solar cabinet dryer for drying of vegetables in hilly area

At hill area in Bangladesh, various vegetables have been produced and the hilly people dry their some vegetables by sun drying method and stored to consume in off season period. In this reason, a solar cabinet dryer is needed in hilly area in Bangladesh to produce good quality, safety and nutritious dried vegetables products. A solar cabinet dryer was designed and fabricated at Farm Machinery and

Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipurunder the project of “Development and adoption of solar cabinet dryer for vegetable seeds”financed by KGF, farmgate, Dhaka. It is an indirect solar cabinet dryer that consisted of drying chamber, collector and auxiliary heating source (electric heaters). The moist radish (9.0 kg) was collected from farmers’ of Khagrachari. The dryer was tested with the moist radish at Hill Agricultural Research Station, Khagrachri during 17-18 February 2020. Drying temperature, relative humidity, air velocity and solar radiation were recorded. After drying, final weight of radish was 554 g. Inside air temperature of the drying chamber varied from 45.45 to 52.5 °C (first day) and 47.44 to 52.5 °C (second day). Air relative humidity in the drying chamber varied from 13.2 to 20.5 % (first day) and 11.53 to 18.5 % (second day), whereas the relative humidity in the ambient varied from 30.54 to 67.47 % (first day) and 42.25 to 65.25 % (second day). Collector outlet air relative humidity was found lower than the ambient air relative humidity. The global solar radiation varied from 50 to 900 W/m2 during testing period. Moist radish dried in the dryer attained final moisture content of 9.0 % (wb) from initial moisture content of 94 % (wb) after 11 hours of drying period whereas, it took fifty six hours to reduce the moisture content to 12 % (wb) of similar sample in open sun. In open sun drying method 9.0 kg moist radish dried to 380 g. In open sun drying method radish losses by 30 % during drying as a result of fungus’s attack. The capacity of the dryer was 18-20 kg/batch. Color of dried slices in dryer was more brightness and smell was good compared to sun drying of radish slices. The dryer maintained nutrition and made hygienic and safety products of radish slices. Hilly farmers and small scale traders would be benefited using the BARI solar dryer.

Performance of BARI released mango varieties in Chattogram hill tracts

An experiment was conducted with five BARI developed mango varieties such as 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, Rangamati Hill District during 2019-20 on the existing eleven years old mango orchard with an objective to verify their performance. The maximum plant height (805 cm), highest fruits per plant (253) and yield (23.5 t/ha) was observed in BARI Aam-8. The highest fruit weight (370g), highest fruit Breadth (9.2 cm) and fruit thickness (7.3cm) were found in BARI Aam-4. The maximum TSS (12.5%)and highestedible portion (81.5%) were recorded in BARI Aam-2. The lowest number of fruits per plant (124), edible portion (64.9%) and fruit yield (5.9t/ha) were found in BARI Aam-1.

Evaluation of mango germplasm for green consumption at hill valley in Chattogram hill tracts

An experiment was conducted at hill valley of Hill Agricultural Research Station of Raikhali, Rangamati Hill District during 2019-20 to find out the best green mangogermplasm. The highest number of fruits per plant (99) was found in MIRai008 and the lowest number of fruits per plant (42) was in MIRai006. The heaviest individual fruit weight (253 g) and highest edible portion (80.1%) were recorded in MIR008 on the other hand lowest fruit weight (111 g) was found in MIR007. The maximum TSS (11%) was found in germplasm MIR008. Germplasm MIR008 was found very well in organoleptic test.

Evaluation of wood apple (*Feronialimonia*) in hilly area of Rangamati

An experiment was conducted at hill valley with four genotypes of wood apple at Hill Agricultural Research Station (HARS), Raikhali, Rangamati Hill District during 2019-20.Maximum number of fruits (198), yield per plant (90.1 kg) and edible portion (59.0 %) was found in FLRai003 germplasm.

Evaluation of phalsa (*Grewiaasiatica L.*) in hilly area of Rangamati

An experiment was conducted at the established minor fruits orchard of Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2019-20 with four phalsa genotypes. Maximum yield per plant (8.7 kg), fruit length (9.21 mm), highest TSS (24.6 %) and fruit yield (3.6 t/ha) was found in the genotype GARai002 on the other hand highest 100 fruit weight (61.1 g) was measured in the genotype GARai003.

Evaluation of pummelo (*Citrus grandis* Osbeck) in hilly region of Rangamati

An experiment with seventeengermplasms of pummelo was conducted at the existing eleven years old orchard of pummeloplants 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 2019-20 for the evaluation of superior pummelogenotypes in hilly region. The maximum number of fruits per plant (65) was observed in CGRai052 followed by CGRai008 (60), whereas the minimum (14) in CGRai011. The earliest flowering (mid February) was recorded in CGRai006 and the most late (mid March) in CGRai047. The highest weight ofindividual fruit (1500g) was recorded in CGRai010 followed by CGRai011 (1400g). Highest edible portion (66%) also found in CGRai010. Maximum TSS (12.5%) was recorded in CGRai014. The genotypes CGRai007, CGRai009, CGRai014, CGRai030 and CGRai047 were found promising.

Evaluation of pumpkin lines for winter season cultivation at hill valley

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2019-20 to find out the suitable pumpkin lines to develop as a variety. Experimental lines varied significantly for their response to days to 1st flowering (DFF), node order of first female flower (NFF), fruit length (FL), fruit width (FW), flesh thickness (FT), individual fruit weight (IFW), yield and TSS (%). Of these, DFF ranged from 65-75, NFF 15-19, FL 10-17, FW 11.7-23.3, FT 2.3-5.0, yield (t/ha) 13-30 and TSS (%) 8.3-14.2. Minimum node order of first female flower (15) was observed in CMRai020. The highest yield (30 t/ha) was found in CMRai0019 followed by CMRai017 (27 t/ha) and lowest (13 t/ha) was found in CMRai004and CMRai013.

Evaluation of year round muskmelon germplasm at hill valley of Chattogram hill tracts

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2019-20 to find out the suitable year muskmelon lines to during as a variety Experimental lines varied for their response to days to 1st female flowering (DFF), node order of first female flower (NFF), fruits per plant (FPP), fruit length (FL), fruit girth (FG), flesh thickness (FT), average fruit weight (AFW), yield per plot and TSS (%). Of these, DFF ranged from 27.0-34.3, NFF 6.7-10.7, FPP 7.3-2.5, FL 24.4-47.2, FG 10.7-17.9, FT 2.20-2.52, AFW(gm) 1700-6700,yield per plot (kg/2.25m^2) 6.0-20.8, yield(t/ha) 26.5-92.2 and TSS (%)ranged from 2-4.7. Minimum node order of first female flower (6.7) was observed in CMRai004. The highest yield (92.2 t/ha) was found in CMRai017 followed by CMRai008 (70.7 t/ha) and lowest (26.5 t/ha) was found in CMRai016 treatment.

Evaluation of some newly collected french bean germplasm

The experiment was conducted at Hill Agricultural Research Station, Raikhali, Rangamati Hill District during 2019-20 to find out the suitable French bean lines in order to release as a variety. BARI Jharsheem-2 was used as check variety. Of these, 50% flowering ranged from 33-40, Plant height 46.7-268.3, Pod length 11.8-19.1, Pod weight 0.7-1.7, Green pod per plant 1214-1908, individual pod weight 5.2-8, pod yield (t/ha) 8,96-12.2 and seed yield (t/ha) 5.6-10.0. The highest seed yield (10 t/ha) was found in PVRai001 followed by PVRai004 (7.5 t/ha) and lowest (5.6 t/ha) was found in PVRai005.

24 AGRICULTURAL STATISTICS AND ICT

Characterizing dry season's agricultural land use in northwest Bangladesh: spatial dynamics and water use

Bangladesh Agricultural Research Institute (BARI) and Commonwealth Scientific and Industrial Research Organization (CSIRO) have been developing methods to map dry season crops including wet season Aman rice and estimating their water use from freely accessible satellite data supported by ground sampling, expert knowledge, machine learning image processing algorithms, and high performance computing system. The overall aim of the research is making a diagnosis and analysis of data and methodologies for crop mapping and water use estimation via remote sensing. A supervised classification algorithm using multi-temporal vegetation indices (VIs) such as EVI, GVMI and NDWI to map crop types and their water use were implemented. Some 14 cropping patterns including major crops such as Aman and Boro rice, wheat, maize and potatoes of this region were estimated for this research. However, historical Boro and Aman rice were mapped from 1985-2015. On the other hand, a water balance model approach that considered changes in irrigated agriculture was implemented to assess changes over the long-term to three five-year evaluation periods (1985–1989, 1998–2002 and 2011–2015) and seasonally (annual, dry season and wet season). The model used two different methods that explicitly capture changes in irrigation to compute and compare actual evapotranspiration (ETa). The first method used MODIS satellite data to estimate a crop coefficient based on vegetation indices (at 500 m spatial resolution) scaled by reference crop evapotranspiration (ETref). The second method used a crop coefficient approach based on survey data of crop areas at the district level and subsequently scaled by ETref. Both methods yielded very similar results at the district level, with correlation coefficients between 0.75 and 0.89. The maximum difference between the monthly averages was only of 5.4%. Notwithstanding the observed overall increase in irrigated areas, estimated overall mean annual ETa is similar through the analysis (ca. 1100 mm) and district-level trends were mixed showing in some districts a weak association between ETa and the related declining groundwater level. From the water balance, it is inferred that both the groundwater extraction (by pumping for irrigation and capillary rise to supply roots) and the groundwater recharge reduced from 1998–2002 to 2011–2015, and with deeper groundwater in later years, much of the irrigation water supply is by soil water storage rather than by groundwater. As highlighted in this study, there are other factors aside crop expansion that may have contributed to the groundwater decline, thus a single policy or management change such as restricting groundwater extraction for irrigation may alone be inadequate to reverse declining groundwater trends.

Assessment of cropping patterns for sustainable intensification in drought prone ecosystem using remote sensing and geospatial modeling

Remote sensing and geospatial modeling can play a vital role to assess cropping patterns and availability of natural resources on the ground and allocate them judiciary for SI in agriculture. Geospatial modeling can help allocate an appropriate cropping-pattern based on the best judicial use of available natural resources. Hence, in order to facilitate sustainable cropping intensification in the problem agro-environments of Bangladesh, current research project has been initiated to carry out in the drought-prone agro-ecosystems prevailing in the Barind Tract region of Bangladesh. During the reporting period (July 2019-June 2020), a reconnaissance survey (2nd) was done for unmanned aerial vehicle (UAV) flight site selection. Necessary ground data were collected as well from study area to train satellite images for crop type mapping. A crop inventory for entire Barind Tract region was prepared according to methodological framework. Six major crop types, predominant in the area, were chosen for delineation from satellite image classification namely: maize, lentil, mustard, potato, Boro rice, and wheat. A total of 28 cloud-free Sentinel 2A (MSS, level-1C) satellite imagery (10m spatial and 10 days temporal resolution) were downloaded (https://scihub.copernicus.eu/) of recent year 2019-2020 for dry season (October-March). These imageries were analyzed using desktop based geospatial software tools and Google Earth Engine (GEE) platform. Among the derived single band Normalized Difference Vegetation Index (NDVI) images, three corresponding date imagery (February 2020 in red band, January 2020 in green band, and December 2019 in blue band) were selected and formed RGB composite image for further analysis. The training dataset was prepared in GIS domain considering earlier-mentioned classes widespread throughout the study area. During the reporting period (July 2019-June 2020), an algorithm was developed to delineate dry season crops using Sentinel-2 imageries in a pilot area (Godagariupazila). Maximum likelihood classification (MLC) technique was employed to classify the NDVI composite image and final classified image including six crops. The results show that Boro rice and lentil occupied most of the area with 8,543.12 ha (17.35% of the total upazila) and 8,381.55 ha (17.02%), respectively. Wheat, mustard, maize and potato shared area 2,087.89 (4.24%), 1,731.55 (3.52%), 798.76 (1.62%) and 658.58 ha (1.34%), respectively during 2019-2020 Rabi season. Others area (water bodies, others crops, orchards, settlement, etc.) shared the maximum area coverage with 27,052.42 ha (54.92%). The overall accuracy of the classified map was found 75% while comparing with the ground truth data, which indicates the satisfactory results. Besides, a set of agro-environmental resources geo-database from image analysis were developed such as digital elevation model, slope map, aspect map, and soil map for the selected upazila.

Non-destructive determination of mango maturity using hyperspectral remote sensing techniques

The non-destructive on-plant assessment of fruit ripeness has received increasing interest as it provides several advantages compared with traditional destructive methods. Hyper-spectral remote sensing technology is a promising field of research for nondestructive quality assessment. The aim of this work is to evaluate the use of hyper-spectral technique for detecting the maturity of mango (BARI Aam-4) based on its major physico-chemical parameters. Diffuse reflectance spectra in region of 400–1075 nm were used to develop calibration models for firmness, total soluble solids (TSS), p^H, Sugar content, ripening index and other physico-chemical parameters. Before estimating these calibration models, spectral data were pre-treated through different transformation techniques to improve the predictability of the models as these transformations can reduce the problems associated with noise, light scattering and external effects in raw spectral. One linear method included partial least squares regression (PLSR) and one machine learning method included least-squares support vector machine (LS-SVM) will be investigated after obtaining the data from destructive analysis as the data from destructive analysis was not completely prepared at the time of writing this report. A robust technique will be developed for predicting mango maturity conditions in this study.

Satellites and ICT based location and crop specific irrigation advisory system for growing more with less water

Given the innovations in information and communication technology (ICT) and integrated satellite geodatabase system for monitoring and predicting conditions of agricultural land, it is now time to rethink the entire strategy of agricultural management. Such a rethinking should be driven by the need to improve food-water security and resilience to extremes such as droughts and floods. Herein, the proposed research aims to build and pilot for upscale to the entire Bangladesh later an irrigation advisory based on integrated satellite-model database system through collaborative research among BARI and the University of Washington. The proposed research herein will bridge the information gaps experienced by a farmer on when and how to optimize irrigation by developing a product/service on his mobile device (phone) which would combine latest developments in sensors, remote sensing (space and ground) and data communication technologies with traditional farming wisdom. This collaborative research was taken to develop irrigation advisory and decision support systems for the farmers of Bangladesh at multiscale (from plot scale to regional scale) using real-time integrated satellite and model database systems with ground-based monitoring infrastructure. So far, a demo version of the irrigation advisory was prepared with support from an external private firm. This demo version contains four main menus such as dashboard, farmers' information, crop information and advisory log. Farmers' information of irrigation advisory system contains the farmers' list based on the crops. Crop information of irrigation advisory system mainly has the Kc value of the particular crop during the growing period. Irrigation advisory log contains details of farmers and the advisory messages sent to them. The irrigation advisory system is under development phase. Development of the complete version of the system and its piloting in the field is dependent on the release of innovation fund that was awarded to the principal author of this program in the last year.

Determinants of household food security in rural Bangladesh: An analysis of farm level data

The study endeavors to estimate the food security status and identify the determinants of food security among households in Hakimpur Upazila in Dinajpur district, Aditmari Upazila in Lalmonirhat district, Saghata Upazila in Gaibandha district, Domer Upazila in Nilphamari district of Bangladesh. It was found that households of Hakimpur upazila in Dinajpur, Aditmari Upazila in Lalmonirhat district, Saghata Upazila in Gaibandha district, Domer Upazila in Nilphamari district were food insecured during the period of the survey. Number of dependents, income of household head, age of household head and level of education were found to significantly influence household head food security in the study area positively. It is recommended that social security measures must ensure that the benefits of public efforts to improve food security and nutrition are universal. Human rights based practices are preferable.

Effects of climatic extreme indicator on potato yield of Bangladesh

Extreme climate events have a great impact on the agriculture-based economy like Bangladesh. This study is conducted mainly to gain insight on the overall condition of extreme air temperature of suitable potato growing area in Bangladesh and the effects of some climate extreme indices on potato yield. The result of trend analysis of extreme climate indices indicated that the monthly maximum value daily minimum temperature has continued to increase. While the monthly minimum value of both minimum and maximum temperature has continued to decrease. It is not possible to identify any specific trend for both monthly maximum value of daily maximum temperature. And for precipitation variable, monthly maximum 1-day precipitation also does not follow any particular pattern. Investigating the effects of these extreme indices, it is found that the monthly maximum of daily maximum temperature and monthly maximum of daily minimum temperature has a significant positive impact on potato yield. And other three extreme indicators have negative effects. These positive factors are much more significant on potato yield than those negative factors. Positive factors follows positive trend and negative factors follows negative trend or does not follow any trend at all. Based on this study, it can be said that the yield of potato is increasing not only due to high yielding variety and soil condition but also climate extreme has some positive impact on the increasing trend of potato yield.

Development of an interface or a package for genotype × environment (GE) interaction analysis using R

This study was undertaken to develop a user-friendly interface using R software or a package for R which gives an output for genotype stability and location value using univariate and multivariate models. At that time there was some paid software that can do these analyses. Also, some complex R packages were available but they lack some features. So, it was needed to develop a simple package and later may be a user-friendly interface to do this analysis.But before we started our research, Tiago Olivoto and Alessandro Dal'Col Lucio, Department of Crop Science, Federal University of Santa Maria, Santa Maria, Rio

Grande do Sul, Brazil has introduced an R package called 'metan' on multi-environment trial analysis in February 2020.Using this package one can analyze what this proposed study was intended to do. It covers not only this GE interaction analysis but also the whole stability analysis as well. We have illustrated an example of GGE analysis on a built-in dataset and found it effective for analysis.

Genome-wide identification, characterization and diversity analysis of RNA silencing machinery genes in brassica species (*Brassica rapa*) using bioinformatics approaches

Dicer-Like (DCL), Argonaute (AGO), and RNA-dependent RNA polymerase (RDR) gene families are known as RNA silencing machinery genes or RNAi genes. They have essential roles at both the posttranscriptional and chromatin modification levels. These genes generally control the expression of genes against different biotic and abiotic stresses during plant growth and development. A whole round of gene silencing takes place by the contribution of the members of these three gene families. However, these gene families have not been yet rigorously studied in the genome of the economically important oilseed crop *Brassica rapa* species. In this work, the bioinformatic analysis-based genome-wide identification, characterization, and diversification of the RNAi genes revealed 4 BrDCL, 13 BrAGO and 6 BrRDR genes from the *B. rapa* genome against the RNAi genes of *Arabidopsis thaliana* using BLAST. Phylogenetic analysis with *Arabidopsis* RNAi genes showed that BrDCL, BrAGO and BrRDR proteins clustered into four, nine and five groups respectively. Domain composition analysis revealed that the BrDCL, BrAGO and BrRDR protein members of these three groups have conserved identical domain characteristics within each group of their *Arabidopsis* counterpart. *Cis*-regulatory components in the promoter regions of the BrDCL, BrAGO and BrRDR protein members are predicted to act as regulatory components by binding particular transcription factor for performing various biological and molecular actions for regulation of specific gene expression by confronting different environmental factors. Expressed sequence tag (EST) analysis showed that the maximum 11 *B. rapa* RNAi out of 23 genes are predicted to express in flower/floral bud followed by leaf, root silique and ovule but in *B.napus* genome the maximum proteins are predicted to express in seed/seed coat followed by flower/flower bud. Overall results would therefore help oilseed molecular breeders and biotechnologists for more in-depth biological and molecular investigations about the important functionalities of *B. rapa* RNAi genes for oilseed crop improvement and disease control of the BARI developed different varieties.

Service Activities of ASICT

Web Information

BARI developed technologies and related information are being publishing regularly through its own web site (www.bari.gov.bd & বিএআরআই.বাংলা) and mobile apps. In addition to technologies, some important issues like tender circular, job circular, journal publication, annual report etc. are also hosted as and when necessary. Total 5064 information has been uploaded in the website and mobile apps during 2019-2020.

Query-Answer

BARI has started online e-agriculture services for the beneficiaries. Any stakeholder can ask question related to agriculture with the help of online facility of BARI web site and Mobile web apps. BARI has been giving services on-line feedback through website (www.bari.gov.bd) and Mobile web apps (baritechnology.org/m) to end users. During 2019-2020, BARI has provided answers of all 248 questions after soliciting from 13Centres/Divisions.

Citizen Information Service Centre

BARI has started disseminating technological information to the citizen. Any citizen can come and obtain his/her required agricultural technological information/service directly from Citizen Information Service Centre and/or from respective crop centre/research division at BARI. During 2019-20, 126 citizens of different professionals from 12 districts has visited BARI citizen services information centre and got services on 15 different areas.

Ensuring access to information of citizens through the Right to Information Act

BARI has appointed personnel to ensure citizen's access to the information in an easiest way. During

2019-20 BARI has provided information to the four citizens as citizen'saccesstoinformation. BARI has also provided answers of all 248 questions received through website and mobile apps.

Online based service to the citizen

BARI has started providing online based services to the citizens. Each year at least one online based service would be developed. During 2019-20, one service entitled BARI Telephone Directory has been developed. Any person from anywhere can get the contact details of BARI personnel through this mobile app which has been published in the Play Store and can be downloaded from https://play.google.com/store/apps/details?id=com. baridirectorey.iamsh.baridirectorey.

Table 1. List of online based services in BARI

Sl.	Link	Service	Year
1.	https://bari.taletalk.com.bd	Job application	2016-17
2.	https://baritechnology.org/crpt	District wise cropping pattern	2017-18
3.	https://baripmis.org/apa	Online APA reporting	2018-19
4.	https://baripmis.org/form-app	Online Loan Management	2018-19
5.	https://play.google.com/store/apps/details?id=com.baridirectorey.iamsh.baridirectorey	BARI Telephone Directory	2019-20
6.	https://geomango.bariarsamlab.net	Satellite based mango orchard mapping in Rajshahi region	2019-20

Service simplification (SPS) to the citizen

BARI has started service simplification using ICT. Each year at least one service simplification would be developed. During 2019-20, one service simplification called 'Online based Query-Answer' has been developed for providing quick responses to the citizen's queries regarding the BARI developed variety and technology.

Table 2. List of service simplification in BARI

Sl. No.	Type	Service	Year
1.	Information centre	Citizen information services	2016-17
2.	Collection of seed and seedling	Limited collection of BARI develop variety seeds and sapling.	2017-18
3.	Collection and preservation of personal information	Information collection & preservation of BARI scientists/officer/staff	2018-19
4.	Online based Query-Answer	Providing quick responses to the citizen's queries regarding the BARI developed variety and technology	2019-20

ICT based innovation to the citizen

BARI has been started ICT based innovation to the citizen services. Each year at least one ICT based innovation must be developed. During 2019-20, a satellite-based mango area monitoring system called "GeoMango" has been developed.

Table 3. List of ICT based innovation to the citizen services in BARI.

Sl. No.	Type	Innovation	Year
1.	Apps	Krishi Projukti Vander	2016-17
2.	Online service	Faster analysis of soil samples	2017-18
3.	Apps	Mobile apps for mango yield estimation	2018-19
4.	Web Apps	GeoMango: Satellite-based mango orchard mapping	2019-20

Social Networking (Facebook)

BARI has been disseminating its regular activities among public through social networking. Any person can ask and interact with BARI authority regarding technologies and/or other information through its official Facebook page (www.facebook.com/BD.GOV.BARI). At present BARI facebook page is followed by more than 9500 facebook users. During 2019-20, a total of 367 posts or public Q/A were moderated/addressed through BARI facebook page.

Web based mail services

BARI has its own domain of email connectivity under the name "bari.gov.bd". Up to date a total 695 webmail 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 has been giving services on LAN & Antivirus maintenance especially for the head quarter scientists and officers. Rendering 24 hours internet services at BARI headquarters.At present more than 500 computers are connected with network and provided with a corporate version of antivirus.

Table 4. Network and Antivirus maintenance during 2019-20

SI.No.	Subject	Number
1.	Trouble shooting for LAN & internet connectivity	733
2.	Trouble shooting for Antivirus	344
3.	New internet connectivity	39
4.	Network connection repair	33
	Total	1149

Wi-Fi connectivity

BARI has established Wi-Fi connectivity in different places. ASICT division was giving services on Wi-Fi & maintenance especially for the head quarter scientists and officers. At present 454 devices are connected in Wi-Fi network.

Statistical analysis service

ASICT division has been giving services on statistical analysis through computer package software such as R and SPSS. Some important analysis of 25 experiments requested by the scientists from 11 different Centres/Divisionshave been done by this division during 2019-2020.

E-Governance

(a) e-Filing system

Access to Information (a2i)has been established e-filing system in BARI Head Quarter(HQ), Crops Center and RARS. ASICT division has been assisted on e-filing system especially for the Head Quarter, Crops Center and RARS personnel. At present 157personnel are connected in e-filing system.

Table 5a. List of file and letter issued in HQ through e-filing system during 2019-20

SN.	Name of Wing/Centre/ Division/Section	No. of file (2019-20)	No. of letter issued		
			2017-18	2018-19	2019-20
1.	DG Office	3	17	220	211
2.	Support and Service wing	0	0	3	0
3.	Research Wing	5	4	92	79
4.	Training & Communication Wing	98	3	8	21
5.	Planning and Evaluation Wing	17	18	32	113
6.	Horticulture Research Center	118	80	69	64
7.	Oilseed research center	10	512	297	118
8.	Tuber Crops Research Center	479	54	155	106
9.	Plant Genetic Research Center	14	46	50	43
10.	Agronomy Division	7	50	87	23
11.	Plant Breeding Division	31	203	190	108
12.	Soil Science Division	73	312	828	99
13.	Entomology Division	112	39	100	27
14.	On-Farm Research Division	1	79	66	36

SN.	Name of Wing/Centre/ Division/Section	No. of file	No. of letter issued		
15.	Agricultural Economics Division	54	22	21	138
16.	FMPE Division	18	100	91	82
17.	IWM Division	1	71	126	25
18.	ASICT Division	44	36	33	111
19.	Postharvest Technology Division	23	52	3	19
20.	Biotechnology Division	6	133	81	117
21.	Seed Technology Division	1	37	7	28
22.	Plant Physiology Division	6	63	55	21
23.	Vertebrate pest management Division	8	87	127	42
24.	Farm Division	50	0	2	5
25.	Plant Pathology Division	1	0	6	21
26.	Machinery Repair and Maintenance Division	1	84	74	27
27.	Regional Spice Research Center	14	15	5	86
28.	Pulse research sub station	11	50	30	30
29.	Administration Section	108	1078	757	440

*Finance and Accounts, Building & Ground, Common Service and Transport Section did not issue any letter through e-filing system during 2019-20.

Table 5b. Letter issued in HQ, Crops Center and RARS through e-filing system during 2019-20

SN	Name of HQ/Crops Center/ RARS	No. of letter issued
1.	Head Quarters, Joydebpur, Gazipur	2489
2.	Pulse Research Center, Ishurdi, Pabna	2
3.	Spices Research Center, Bogura	61
4.	Regional Agricultural Research Station, Jamalpur	91
5.	Regional Agricultural Research Station, Jessore	114
6.	Regional Agricultural Research Station, Moulvibazar	0
7.	Regional Agricultural Research Station, Barisal	72
8.	Regional Agricultural Research Station, Hathazari	53
9.	Regional Agricultural Research Station, Burirhat	29
10.	Regional Agricultural Research Station, Cumilla	118

(b) e-Tendering system

Central Procurement Technical Unit (CPTU) has established e-tendering system at BARI. ASICT division has been assisted on e-tendering systems especially for the head quarter through two Procurement Entity (PE) offices like Building & Ground section and Procurement & Store section. During 2019-20, 148 E-tendering has been implemented through two PE offices.

Table 6. List of E-tendering during 2019-20

Sl. No	Name of office	E-tendering
1.	Procurement & Store section	54
2.	Building & Ground section	94
	Total	**148**

(c) Labour Management Software

BARI labour management automation has been going on full swing. At present, 53 centre/division /section and 1349 labour information are included in this automation. This automation software is divided into three parts viz, Labour Information, Labour Salary and Labour Report. Each part can be operated solely and has a options to be integrated together as per requirements.

(d) SalarySystemSoftware

BARI payroll management system has been developed for BARI personnel. This system is user friendly. Any person can be used own BARI ID number and prepare his/her salary statement. At present 400 scientist/officer/staff are using this system.

(e) Management Information System (MIS) Software

MIS software is divided into three separate modules viz. Personnel Management Information System (PMIS), Training Management Information System (TMIS), Publications Management Information System (Publication). Each module can be operated solely and has an option to be integrated together as per requirements.

Table 7. Present status of 3 modules

Modules	Achievement (data entry)
Personnel Management Information System (PMIS)	100 %
Training Management Information System (TMIS)	100 %
Publications Management Information System (Publication)	100%

Human resource development

ASICT division has engaged human resources development through various type of training program related to ICT. ASICT division has trained 135 participants through four ICT-based training programs during 2019-2020. Besides, ASICT division has participated at ICT fair and organized field day on mobile apps in different places during 2019-2020.

25 Training & Communication Wing

Training & Communication

During 2019-20, Ten (10) scientists were sent abroad for higher study (Ph. D and Postdoc). One hundred and twenty seven (90) scientists/officers were sent abroad for training/workshop/study tour/visit meeting/ conference etc. Besides, thirty one (10) scientists were sent to different universities in the country for Ph. D degree. Total 270 scientists, officer and staff have been sent in 60 different training courses, 165 scientists attended 23 workshops and 98 scientists attended 5 seminars organized by various organizations in the country.

Seminar & Workshop

Communication Section of T&C arranges seminars and workshops in various fields of agricultural research. A total of 12 (twelve) seminars and 06 (six) workshops were organized at BARI during the year 2019-20 on different aspect of agricultural Knowledge share to achieve the goal of Annual Performance Agreement (APA). A total of 1122 participants of BARI and other national research organization were actively participated in these seminars and workshops.

MoU & LoA singed

During the period 2019-20, BARI had signed MoU with 10 (ten) organizations and LoA with 5 (five) 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 ne wsletter, 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 Central Library 2019-20

A. **Mandate:** BARI Library is mandated to help fulfill the purpose of the institute, as an adjunct of the researcher's tool and it's tends to play a significant role for providing right information to the researchers at the right time. So the mandates are:

- 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.
- Participating inter-library loan and network system to serve the researchers effectively.
- Providing aid on the use of the library and help to find, locate and evaluate the information available in the library.

- Establishing Management Information System (MIS) i.e. digital library and library automation system 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: 85,543

Items	Quantity
Books, Reports, Proceedings, etc.	46,300
Archival collection	2,670
Thesis	848
Periodicals (bound in book form)	4,247
Journal	24,401
Newsletter	622
Bulletin	124
Pamphlets	701
Booklets	243
Reprint	518
Leaflets	4,889

2. Information resources added during the year 2019-2020

a. Books, Reports, Proceedings etc. and Thesis: 142

Items	Purchased	Exchange	Gift / Complimentary	Total
Books	69	07	21	97
Research reports, project reports & proceedings	-	07	23	30
Thesis (MS & Ph.D)	-	-	15	15

b. Serial Publications (printed form)
Journals, Newsletters, bulletins etc : 79

Items	Purchase	Exchange	Gift / Complimentary	Total
Journals	-	30	36	66
Newsletters	-	04	05	9
Bulletins	-	-	4	4

3. Document Processed for Services:

SI No.	Procured material processed	No.
01	**Document Accessioned**	208
02	Catalogued & Classified and pasted with call numbers, book pockets and due slips	155

4. Services Provided to Users:

Sl No.	Services provided to the Scientists	Number
1.	Documents Charged/Discharges	194
2.	Users Referenced	463
3.	Number of photocopies made	5256
4.	Publication Distributed (Journal, Newsletter & Report) in Exchange & Complimentary)	115
5.	Correspondence made	81

5. Online Browsing Facilities:
<u>Subscribed Journals (Publisher's list)</u>

01. American Institute of Physics
02. American Physical Society
03. American Society of Agricultural and Biological Engineers (ASABE)
04. American Society for Civil Engineers
05. Annual Reviews
06. British Institute of Radiography
07. Cambridge University Press (CPU)
08. Canadian Science Publishing (was NRC Press)

09. Cochrane Library
10. EBSCO Host including CMMC
11. Edinburgh University Pres
12. Geological Society
13. Mary Ann Liberty
14. Nature- Nature Research Journals (48 titles)
15. Nature- Palgrave Macmillan Journals
16. Nature- Academic Journals
17. Optical Society of America
18. Policy Press
19. Project MUSE Journals
20. Royal College of Physicians
21. Royal Society
22. Scientific American
23. SPIE Digital Library
24. Springer ALL (2000+ titles
25. Springer- Adis Collection
26. Wiley Online Library- (access limit period 1997-2018)
27. Indian Online Journals

e-Book

28. Project MUSE books 2010-2017
    Complete collection (17,000+ titles)
29. De Gruyter LIS books collection

Complementary journal

(http://login.research4life.org/tacgw/AppPortal/)

AGORA & HINARI

i. http://www.aginternetwork.org
   ID: ag-bgd026
   Password: GQ34ACDX

ii. http://www.who.int/hinari
   ID: BAN053
   Password: 70555

5. **BARI Digital Library:** BARI library has lunched "**BARI Digital Library**" which is associated with both digital and automated library system. Now this digital library is available for user access through internet from anywhere. The web address is www.barilibrary.org. Here SLiMS library software has used. In this page main icons are:

	Icons	Document uploaded
1.	BARI Publications	192
2.	Bengali Books	406
3.	Reference	2411
4.	Booklet	62
5.	Fiction	13
6.	Center's Publication	195
7.	Divisional Publications	136
8.	Newsletter	45
9.	Report	8
10.	Journal	11
11.	Thesis – MS	334
12.	Thesis –Ph.D	389
13.	Leaflet	296
14.	Personal Publications	70
	Total	**4568**

Photography Section

The 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. Bari's activities are also regularly uploaded on the official Facebook page by this section.

Photography Section Covered the following activities during 2019-2020

- To expose, collect, preserve and display photograph of different crop varieties.
- To display photographs of visitors, research, agricultural fairs, BARI technology village activities, publications and other activities on the central display board.

- ❖ Provide new technology, design and ideas to make new generation research community.
- ❖ To co-ordinate ensure all kind of photographic equipment's information.
- ❖ Make video documentary for broadcasting based of the scientists demand.
- ❖ To co-ordinate and supply the photography news of several programme for published the newspapers, magazine, journal, TV etc.
- ❖ To co-ordinate and supply the photographs and news info of the editorial and publication section for newsletter.
- ❖ To co-ordinate and supply the photographs and news info of the ICT for BARI Facebook and website.
- ❖ Coverage the Director General and Directors visit in out station of BARI.

Table- 1. Summary of activities of photography Section during 2019-2020

Sl. No	Activities	Number
1	Photograph exposed in Digital Camera	20,000 above
2	Photo Editing	14,500 above
3	Video Recording programme	10 above

Programme of Photography Section for 2020-2021

- ❖ Make video documentary for broadcasting based of the scientists demand.
- ❖ To expose photographs of different crop varieties. research, agricultural fairs, BARI technology village activities, Field day, Visitors etc.

26 Planning & Evaluation Wing

Introduction

Planning is an organizational process as well as public policy body of an organization for creating and maintaining a plan; and the psychological process of thinking about the activities required to create a desired goal. This process is essential to the creation and refinement of a plan or integration of it with other plans. The term is also used to describe the formal procedures used in such an endeavor, such as the creation of documents to discuss the important issues to be addressed, the objectives to be met, and the strategy to be followed.

A plan serves three critical functions such as-

- Helps management to clarify, focus, and research their activities or project's development and prospects.
- Provides a considered and logical framework for research and activities which could develop and pursue research/activities for the fulfillment of the strategies.
- Offers a benchmark against which actual performance could be measured and reviewed.

Program evaluation is a systematic method for collecting, analyzing, and using information to answer questions about projects, policies and programs, particularly about their performance on effectiveness and efficiency.

As with most things in international development, there is no standard definition of a Monitoring and Evaluation (M&E) framework, or how it differs from an M&E plan. For many organizations, an M&E framework is a table that describes the indicators that are used to measure whether the program is a success.

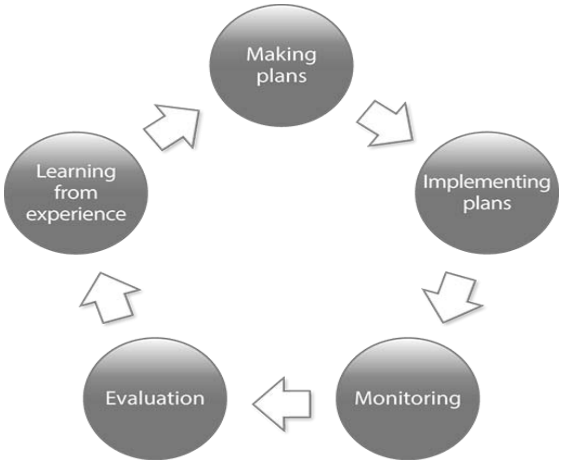


Figure: A Thematic Diagram of Planning & Evaluation Process

For community-engaged initiatives, formative and process evaluation can include evaluation of the process by which partnerships are created and maintained and ultimately succeed in functioning.

Program evaluations are successful if the following three conditions are met:

- Program objectives are well defined in terms of specific measures of program performance (Log Frame)
- Intended uses of evaluations are well-defined, and
- Monitoring and evaluation plans are developed.

Activities of Planning and Evaluation Wing

Planning and Evaluation Wing playing a pivotal role for BARI. Planning is a process of deciding in advance what we want to get (our goal) and how we will get it. Evaluation enables us to assess how well we are doing and to learn from this. The activities of planning & evaluation wing of BARI are:

1. Preparation and processing of Project Proposal (DPP/RDPP/TAPP)
2. Preparation of new skim (Karmasuchi) under revenue budget.
3. Preparation of monthly report (IMED-05) and quarterly report (IMED 02 and 03)
4. Preparation of project director`s profile (IMED-01)
5. Preparation of procurement plan (Works, goods & services), work plan of projects and their subsequent approval by the authority.
6. Monitoring and evaluation of development projects including procurement status (tender related activities).
7. Preparation of Project Completion Report (PCR).
8. Preparation of financial and physical progress report of the project and send to the Ministry of Agriculture
9. Co-ordination of Project Implementation Committee (PIC) meeting.
10. Co-ordination of planning and development co-ordination committee (P&DC) meetings of BARI
11. Liaison with IMED, planning commission and different ministries as and when necessary.
12. Performing other activities as directed by the Director General, BARI.
13. Participate in the monthly ADP review meeting in Ministry of Agriculture.
14. Prepare quarterly / half yearly report according to "Annual Performance Agreement"
15. Preparation of budget and report for "Sustainable Development Goals target, 2030".
16. Preparation of ADP and RADP for on-going & proposed development projects.
17. Preparation of monthly progress report on work plan for prime minister's office and Ministry of Agriculture.
18. Preparation of monthly progress report of "Implementation of Guidelines issued by Honorable Prime Minister"
19. Preparation of answers to the questions of Jatiya Sangshod (National Parliament).
20. Participation in Mid-term budget framework meeting.
21. Preparation of Five Year Plan (FYP).
22. Preparation of research activities according to Sustainable Development Goals (SDGs) which was instructed by cabinet division as well as collaborated with United Nations (UN) and Food and Agricultural Organization (FAO).
23. Preparation of Projects for Delta Plan-2100.

Table 1. Development projects implemented during 2019-20

(In lakh Tk.)

Sl.no.	Name of the Projects (Implementation period)	Total Project Cost	Allocation of 2019-20	Expenditure up to June 2020 & % of allocation		Cumulative Progress upto June 2020
				Financial	Physical (%)	
1.	Improvement and Quality Seed Production of Wheat and Maize-2nd Phase (July 2015 to June 2020)	2332.75	271.00	269.56	99%	2174.35 (93%)
2.	Strengthening of Oilseed and Pulses Research and Development in Bangladesh (April 2016 to June 2021)	2363.59	278.00	278.00	100%	1916.12 (81%)
3.	Strengthening Research on Horticultural Crops and Dissemination of Horticultural & Field Crop Technology in Charland Areas (April 2016 to June 2021)	7055.52	1065.00	1065.00	100%	5424.99 (77%)
4.	Research, Extension and Popularize of Vegetables and Spices Cultivation on Floating Bed (July 2017 to June 2022)	3651.65	554.00	554.00	100%	2015.00 (55%)
5.	Development and expansion of bio-rational based integrated pest management of vegetables, fruits and betel leaf (January 2018 to December 2021)	2085.00	521.00	451.00	87%	1477.00 (71%)
6.	Strengthening of Spices Crop Research in Bangladesh (October 2017 to June 2022)	9400.00	2272.00	2272.00	100%	4408.00 (47%)
7.	Establishment of Agriculture Research Station, BARI, Gopalganj and eco-friendly agricultural development project in south-western part through strengthening of research (July 2018 to June 2023)	15700.00	10102.00	10060.23 (99.56)	100%	10190.23 (65%)
8.	Smallholder Agricultural Competitiveness Project (SACP) (BARI Part) (July 2018 to June 2024)	1457.97	385.00	277.02 (71.45)	100%	319.66 (22%)
9.	Upgrading Regional Horticulture Research Station, Cumilla to Regional Agricultural Research Station (July 2018 to June 2023)	3727.52	489.00	368.98 (75.50)	100%	410.98 (11%)
	Total:	**47774.00**	**15937.00**	**15595.79**	**98%**	**28336.33 (59%)**

Table 2. Development projects to be implemented during 2020-21

(In Lakh)

Sl.no.	Name of the Projects (Implementation period)	Total Project Cost	Allocation 2020-21	Status
1.	Strengthening of Oilseed and Pulses Research and Development in Bangladesh (April 2016 to June 2021)	2363.59	234.00	5th year
2.	Strengthening Research on Horticultural Crops and Dissemination of Horticultural & Field Crop Technology in Charland Areas (April 2016 to June 2021)	7055.52	1622.00	5th year
3.	Research, Extension and Popularize of Vegetables and Spices Cultivation on Floating Bed (July 2017 to June 2022)	3651.65	606.00	4rd year
4.	Development and expansion of bio-rational based integrated pest management of vegetables, fruits and betel leaf (January 2018 to December 2021)	2085.00	252.00	3rd year
5.	Strengthening of Spices Crop Research in Bangladesh (October 2017 to June 2022)	9400.00	2068.00	4rd year
6.	Establishment of Agriculture Research Station, BARI, Gopalganj and eco-friendly agricultural development project in south-western part through strengthening of research (July 2018 to June 2023)	15700.00	3052.00	3rd year
7.	Smallholder Agricultural Competitiveness Project (SACP) (BARI Part) (July 2018 to June 2024)	1457.97	276.00	3rd year
8.	Upgrading Regional Horticulture Research Station, Cumilla to Regional Agricultural Research Station (July 2018 to June 2023)	3727.52	1176.00	3rd year
9.	Farm machinery technology development for profitable crop production (July, 2020- June, 2025)	5600.00	--	1st year
10.	তেলজাতীয় ফসলের উৎপাদন বৃদ্ধি (জুলাই ২০২০ - জুন ২০২৫)	2044.56	--	1st year
	Total		**9286.00**	**-**

Table 3. List of new projects included in the ADP book for 2020-21

Sl.No.	Name of the Projects (Implementation period)	Total Project Cost (In Lakh Tk.)	Remarks
১.	আঞ্চলিক উদ্যানতত্ত্ব গবেষণা কেন্দ্র, নরসিংদীকে আঞ্চলিক কৃষি গবেষণা কেন্দ্রে উন্নীতকরণ প্রকল্প (জুলাই ২০১৯- জুন ২০২৪) Upgrading Regional Horticulture Research Station, Narsingdi to Regional Agricultural Research Station (July 2019-June 2024)	27500.00	কৃষি মন্ত্রণালয়ের পর্যালোচনা সভার সিদ্ধান্তের আলোকে ডিপিপি পূনর্গঠনের কাজ চলছে

Sl.No.	Name of the Projects (Implementation period)	Total Project Cost (In Lakh Tk.)	Remarks
২.	আঞ্চলিক ডাল গবেষণা কেন্দ্র মাদারীপুরের সক্ষমতা বৃদ্ধি এবং বৃহত্তর বরিশাল, ফরিদপুর অঞ্চলে ডাল ফসলের উৎপাদন বৃদ্ধি (জুলাই ২০১৮- জুন ২০২৩) Strengthening Regional Pulse Research Station, Madaripur and increase production of pulse crops at greater Barishal, Faridpur Region (July 2018-June 2023)	17885.00	পিইসি সভা সম্পন্ন হয়েছে, একনেক এর জন্য প্রক্রিয়াধীন।
৩.	উপকূলীয় লবণাক্ত এলাকায় কৃষি গবেষণা জোরদারকরণ প্রকল্প (জুলাই, ২০১৯ - জুন, ২০২৪) Strengthening of Agricultural Research at Coastal Saline Regions Project (July 2019- June 2024)	29045.00	অর্থনৈতিক সমীক্ষা প্রণয়নের কাজ চলছে
৪.	কন্দাল ফসল গবেষণা জোরদারকরণ ফেজ-১ (জুলাই, ২০২০-জুন, ২০২৫) Tuber Crops Research Strengthening Project (TCRSP) Phase-1 (July, 2020- June, 2025)	18248.44	পরিকল্পনা ও মূল্যায়ন উইং, বিএআরআই এর সুপারিশের আলোকে ডিপিপি পুনর্গঠন করা হচ্ছে।
৫.	কিশোরগঞ্জে কৃষি গবেষণা কেন্দ্র স্থাপনের মাধ্যমে এলাকার কৃষির উন্নয়ন (জানুয়ারি, ২০২০-জুন, ২০২৪) Establishment of agricultural research station for agricultural development in Kishoreganj District (January, 2020- June, 2024)	14904.55	কৃষি মন্ত্রণালয়ের যাচাই কমিটির সুপারিশের আলোকে ডিপিপি পূনর্গঠন পূর্বক ১৪-০৬-২০২০ তারিখে কৃষি মন্ত্রণালয়ে প্রেরণ করা হয়েছে
৬.	জলবায়ু সহিষ্ণু ফসল উৎপাদন প্রযুক্তি উদ্ভাবন এবং উন্নয়ন প্রকল্প (জুলাই, ২০১৯ - জুন, ২০২৪) Climate Resilient Crop Production Technology Generation and Development Project (July 2019- June 2024)	36600.50	পরিকল্পনা কমিশনে প্রক্রিয়াধীন। এডিবি-এর আর্থিক সহায়তার সম্মতি পাওয়া গেছে
৭.	জীবপ্রযুক্তি গবেষণা জোরদারকরণ প্রকল্প (জুলাই, ২০২০ - জুন, ২০২৫) (Strengthening of bio-technology research project) (July 2020- June 2025)	3400.00	ডিপিপি প্রণয়ন সম্পন্ন করা হয়েছে।
৮.	দেশব্যাপী সরেজমিন গবেষণা কার্যক্রম জোরদারকণের মাধ্যমে কৃষি উন্নয়ন প্রকল্প (জুলাই, ২০১৯ - জুন, ২০২৪) Agricultural development project all over the country through strengthening of on-farm research (July 2019- June 2024)	84506.00	গত ২২-০৬-২০২০ তারিখে কৃষি মন্ত্রণালয়ে যাচাই কমিটির সভা অনুষ্ঠিত হয়েছে
৯.	পার্বত্য চট্টগ্রাম অঞ্চলে সমন্বিত কৃষি উন্নয়ন প্রকল্প (বারি অংগ) (জুলাই, ২০২০ - জুন, ২০২৫) Integrated Agricultural Development in Chattogram Hill Tract Project (BARI Part) (July 2020- June 2025)	3597.00	কৃষি মন্ত্রণালয়ের যাচাই কমিটির সুপারিশের আলোকে সম্ভাব্যতা সমীক্ষার কাজ চলছে ডিপিপি পূনর্গঠন পূর্বক কৃষি মন্ত্রণালয়ে প্রেরণ করা হয়েছে

Sl.No.	Name of the Projects (Implementation period)	Total Project Cost (In Lakh Tk.)	Remarks
১০.	পাহাড়ী কৃষি গবেষণা জোরদারকরণ প্রকল্প (জুলাই, ২০১৯ - জুন, ২০২৪) (Hill agricultural research strengthening project) (July 2019- June 2024)	48963.00	কৃষি মন্ত্রণালয়ের ব্যয় যুক্তিযুক্তকরণ সভার আলোকে ডিপিপি পূনর্গঠনের কাজ চলছে
১১.	ফল গবেষণা জোরদারকরণ প্রকল্প (জুলাই, ২০১৮ - জুন, ২০২৩) (Strengthening of fruit research project) (July 2018- June 2023)	53025.00	ডিপিপি প্রণয়নের কাজ চলছে
১২.	বসতবাড়ীর আঙ্গিনায় বাগান স্থাপনের মাধ্যমে দারিদ্রপীড়িত কৃষকদের পুষ্টি নিরাপত্তা অর্জন ও আয় বৃদ্ধি (জুলাই, ২০১৯ - জুন, ২০২৪) Achievement of nutritional security and increasing income of poor farmers through establishing homestead garden (July 2019-June 2024)	21618.00	ডিপিপি প্রণয়নের কাজ চলছে
১৩.	বাংলাদেশে কাজুবাদাম ও কফি চাষ গবেষণা, উন্নয়ন ও সম্প্রসারণ (বারি অংগ) (জানুয়ারি, ২০২০ - ডিসেম্বর, ২০২৪) Research, Development & Extension of Cashewnut & Coffee Cultivation in Bangladesh (BARI Part) (January 20- December 2024)	11500.00	পরিকল্পনা কমিশনে প্রক্রিয়াধীন
১৪.	বিএআরআই এর অবকাঠামো উন্নয়ন ও গবেষণা কার্যক্রম জোরদারকরণ প্রকল্প (জুলাই ২০১৯-জুন ২০২৪) Infrastructure development and strengthening of research programme of BARI (July 2019- June 2024)	53560.00	কৃষি মন্ত্রণালয়ের পর্যালোচনা সভার সিদ্ধান্তের আলোকে ডিপিপি পুর্নগঠন পূর্বক ০৯-০৬-২০২০ তারিখে কৃষি মন্ত্রণালয়ে প্রেরণ করা হয়েছে
১৫.	যশোর জেলার ঝিকরগাছায় ফুল গবেষণা কেন্দ্র স্থাপন (জানুয়ারি, ২০২০-জুন, ২০২৪) Establishment of Floriculture Research Centre at Jhikargacha of Jessore District (January, 2020-June, 2024)	23080.00	পিইসি সভা সম্পন্ন হয়েছে, একনেক এর জন্য প্রক্রিয়াধীন।
১৬.	লেবু জাতীয় ফলের গবেষণা জোরদারকরণ ও প্রযুক্তি হস্তান্তর প্রকল্প (জুলাই, ২০১৯ - জুন, ২০২৪) Strengthening Citrus Research and Technology Dissemination Project (July 2019-June 2024)	13414.45	পরিকল্পনা ও মূল্যায়ন উইং, বিএআরআই এর সুপারিশের আলোকে ডিপিপি পুনর্গঠন করা হচ্ছে।

Table 4. New projects under process of development

ক্রমিক নং	প্রকল্পের নাম	প্রাক্কলিত ব্যয় (লক্ষ টাকায়)	অগ্রগতি
১.	মানসম্পন্ন আম লাভজনকভাবে রপ্তানী করার জন্য বাষ্পীয় তাপ শোধন পদ্ধতির উন্নয়ন (জুলাই ২০২০ - জুন ২০২৫) Improvement of vapour heat treatment system for producing quality mango for profitable export (July 2020 - June 2025)	৪৮০০.০০	কৃষি মন্ত্রণালয়ে ০৯ আগস্ট ২০২০ তারিখে পর্যালোচনা সভার সুপারিশক্রমে ডিপিপি পুনর্গঠন করা হয়েছে
২.	সর্জান পদ্ধতিতে বছর ব্যাপী উদ্যানতাত্বিক ফসলের গবেষণা, সম্প্রসারণ ও জনপ্রিয়করণ (জুলাই, ২০১৯ - জুন, ২০২৪) Year Round Research, Extension and Popularization of Horticultural Crops through Sorjan Systems (July 2019-June 2024)	১২৪৪৫.২৪	ডিপিপি প্রণয়নের কাজ চলছে
৩.	ফসল সংগ্রহোত্তর গবেষণা জোরদারকরণ প্রকল্প (জুলাই, ২০২০ - জুন, ২০২৫) (Strengthening of Postharvest Technological Research Project) (July 2020- June 2025)	১৩৬৮৮.০০	ডিপিপি প্রণয়নের কাজ চলছে
৪.	আঞ্চলিক মসলা গবেষণা কেন্দ্র, বিএআরআই, মাগুরা শক্তিশালীকরণ (জুলাই, ২০২০ - জুন, ২০২৫) Strengthening of Regional Spice Research Center, BARI Magura (July 2020- June 2025)	১৬৩৫৩.২০	ডিপিপি প্রণয়নের কাজ চলছে
৫.	পিরোজপুর জেলায় বিএআরআই এর কৃষি গবেষণা কেন্দ্র স্থাপন ও উপকূলীয় জোয়ার প্লাবিত অঞ্চলে কৃষি গবেষণা কার্যক্রম জোরদারকরন (জুলাই, ২০২০ - জুন, ২০২৫) Establishment of Agricultural Research Station of BARI in Pirojpur District and Strengthening Agricultural Research in Coastal Tidal Flood Plain Region (July 2020- June 2025)	২০২৭৯.৬৫	ডিপিপি প্রণয়নের কাজ চলছে
৬.	বিএআরআই এর আঞ্চলিক কেন্দ্র ও উপকেন্দ্র সমূহের ল্যাবরেটরী ও গেস্টহাউজের সক্ষমতা বৃদ্ধিকরণ প্রকল্প (জুলাই, ২০১৯ - জুন, ২০২৪) Upgradation and Capacity Building of Regional and Sub- Stations Laboratory and Guesthouse under BARI (July 2019-June 2024)	৫২৫০০.০০	ডিপিপি প্রণয়নের কাজ চলছে
৭.	বিএআরআই এর মানব সম্পদ উন্নয়ন ও প্রযুক্তি হস্তান্তর কার্যক্রম জোরদারকরণ প্রকল্প (জুলাই, ২০২০ - জুন, ২০২৫) Strengthening of human resource development and technology transfer activities of BARI (July 2020- June 2025)	২০৭৩৮.০০	ডিপিপি প্রণয়নের কাজ চলছে
৮.	বিলুপ্ত প্রায় বিরল প্রজাতির দেশীয় ফল এবং অন্যান্য ফসলের ক্লাইমেট স্মার্ট জার্মপণ্যাজম চিহ্নিত করণ, সংগ্রহ, মূল্যায়ন ও সংরক্ষণ জোরদারকরণ (জুলাই, ২০১৯ - জুন, ২০২১)	১৫০০.০০	ডিপিপি প্রণয়নের কাজ চলছে

ক্রমিক নং	প্রকল্পের নাম	প্রাক্কলিত ব্যয় (লক্ষ টাকায়)	অগ্রগতি
	Identification, Collection, Conservation and Evatution on Indengerd and Rare Species of Indigenous Fruits and other Climate Smart Germplasm (July 2019-June 2021)		
৯.	মেহেরপুর জেলায় বাংলাদেশের কৃষি গবেষণা ইনস্টিটিউটের কৃষি গবেষণা কেন্দ্র স্থাপন (জুলাই ২০২০ - জুন ২০২৫) Establishment of Agricultural Research Station of BARI in Meherpur District (July 2020-June 2025)	--	ডিপিপি প্রণয়নের কাজ চলছে

Table 5. Scheme implemented by BARI during 2019-20

(লক্ষ টাকায়)

ক্রমিক নং	কর্মসূচির নাম ও মেয়াদকাল	মোট বরাদ্দ	২০১৯-২০ অর্থ বছরের বরাদ্দ	জুন/২০২০ পর্যন্ত অগ্রগতি	আর্থিক অগ্রগতি %	জুন/২০২০ পর্যন্ত ক্রমপুঞ্জিত অগ্রগতি
১	২	৩	৪	৫	৬	৭
১.	খেসারী, মাসকালাই ও ফেলনের জাত উন্নয়ন, বীজ উৎপাদন এবং সংগ্রহোত্তর প্রযুক্তি উদ্ভাবন ও বিস্তার কর্মসূচি। (জুলাই, ২০১৭ - জুন, ২০২০)	৩১৪.০০	১১০.০০	১০০.০০	৯১%	৩০৪.০০ (৯৭%)
২.	কাঁচা কাঁঠালের ভেজিটাবল মিট প্রক্রিয়াজাতকরণ কর্মসূচি (জুলাই, ২০১৭ - জুন, ২০২০)	৫৪৯.৩৯	১২৭.৯০	১২৭.৮৬	১০০%	৫৪৭.১০ (১০০%)
৩.	আমের স্থানীয় জাতের উন্নয়ন, উৎপাদন প্রযুক্তি উদ্ভাবন এবং বারি উদ্ভাবিত প্রতিশ্রুতিশীল জাতসমূহের মাতৃকলম উৎপাদন ও বিতরণ কর্মসূচি (জুলাই, ২০১৭ - জুন, ২০২০)	৫১৫.০০	২১০.০০	২১০.০০	১০০%	৫১৫.০০ (১০০%)
৪.	ফসল নিবিড়তা বৃদ্ধিকরণে চার ফসল ভিত্তিক ফসল বিন্যাস উদ্ভাবন ও বিস্তার কর্মসূচি (জুলাই, ২০১৭ - জুন, ২০২০)	৩২০.০০	১৫০.০০	১৫০.০০	১০০%	৩২০.০০ (১০০%)
৫.	অপ্রচলিত তেল ফসলের (সয়াবিন, সূর্যমুখী এবং তিসি) গবেষণা ও উন্নয়ন জোড়দারকরণ কর্মসূচি (জুলাই, ২০১৭ - জুন, ২০২০)	৩১০.০০	১৪০.০০	১৪০.০০	১০০%	৩০৬.২৫ (৯৯%)
৬.	পিঁয়াজের প্রজনন বীজ উৎপাদন কর্মসূচি (জুলাই, ২০১৭ - জুন, ২০২০)	১৬২.০০	৪৫.০০	৪৫.০০	১০০%	১৬২.০০ (১০০%)
৭.	কাঁচা আম প্রক্রিয়াজাতকরণ ও সংরক্ষণ কর্মসূচি (জুলাই, ২০১৭ - জুন, ২০২০)	৬৯.৬১	২৩.৯৮	২৩.৯৮	১০০%	৬৯.৬১ (১০০%)
৮.	গোলমরিচ, কালিজিরা এবং জিরাসহ অন্যান্য অপ্রচলিত মসলা ফসলের গবেষণা, জাত ও প্রযুক্তি উন্নয়ন কর্মসূচি (জুলাই, ২০১৭ - জুন, ২০২০)	৩৩২.৫০	৯০.৭৫	৯০.৭২	১০০%	৩৩২.৪৭ (১০০%)

ক্রমিক নং	কর্মসূচির নাম ও মেয়াদকাল	মোট বরাদ্দ	২০১৯-২০ অর্থ বছরের বরাদ্দ	জুন/২০২০ পর্যন্ত অগ্রগতি	আর্থিক অগ্রগতি %	জুন/২০২০ পর্যন্ত ক্রমপুঞ্জিত অগ্রগতি
১	২	৩	৪	৫	৬	৭
৯.	উপকূলীয় অঞ্চলের লবনাক্ত জমিতে সূর্যমুখী উৎপাদন ও বিস্তার এবং সংগ্রহোত্তর প্রযুক্তি উদ্ভাবন কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	১৩৪.৯৫	৬৬.৯০	৬৬.৮৮	১০০%	৮১.৮৮ (৬১%)
১০.	চীনাবাদামের উন্নত জাত ও আন্তঃফসল প্রযুক্তি উদ্ভাবনের মাধ্যমে চরাঞ্চলের কৃষকদের পুষ্টি ও আর্থিক অবস্থার উন্নয়ন কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	৯৬.৫০	৪১.৫০	৪১.৪৮	১০০%	৫৬.৪৮ (৫৯%)
১১.	বাংলাদেশে অর্কিড, ক্যাকটাস-সাকুলেন্ট ও বাল্ব-করম জাতীয় ফুলের জাত উন্নয়ন, উৎপাদন, সংগ্রহোত্তর ও মূল্য-সংযোজন প্রযুক্তি উদ্ভাবন এবং বিস্তার কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	৩৪৬.০০	১৫৬.০০	১৫৬.০০	১০০%	২০১.০০ (৫৮%)
১২.	উপকারী নভেল বেসিলাস ব্যাক্টেরিয়া দ্বারা উৎপাদিত জৈব পণ্য ব্যবহার করে বেগুনের ঢলে পড়া রোগ নিয়ন্ত্রণের প্রযুক্তি উদ্ভাবন ও বিস্তার কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	২৮২.০০	১৯৭.০০	১৯৭.০০	১০০%	১৯৭.০০ (৭০%)
১৩.	বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউটের উদ্ভিদ রোগতত্ত্ব গবেষণাগার এ্যাক্রিডিটেডকরণ কর্মসূচি (জুলাই, ২০১৯ - জুন, ২০২০)	৯২৭.৪৫	৯২৭.৪৫	৯২৭.৪৪	১০০%	৯২৭.৪৪ (১০০%)
১৪.	জোয়ার ভাটা প্রবণ দক্ষিণাঞ্চলের পতিত জমিতে উদ্যানতাত্ত্বিক ফসলের উপযোগিতা যাচাই পূর্বক উৎপাদনশীলতা বৃদ্ধি (জুলাই ২০১৯ - জুন ২০২২)	১৭৮.৯৪	১২.০০	১২.০০	১০০%	১২.০০ (৭%)
১৫.	নিরাপদ ফল ও সবজির উৎপাদন এবং তাদের রপ্তানি বৃদ্ধিকরণ কর্মসূচী (জুলাই ২০১৯ - জুন ২০২২)	৬০৯.৩০	১৯.০০	১৯.০০	১০০%	১৯.০০ (৩%)
১৬.	বাংলাদেশের দক্ষিণাঞ্চলে চাষকৃত গুরুত্বপূর্ন ফল, পান, সুপারি ও ডাল ফসলের ক্ষতিকারক পোকামাকড় সনাক্তকরন ও সমন্বিত বালাই ব্যবস্থাপনার মাধ্যমে নিরাপদ ফসল উৎপাদন প্রযুক্তি উদ্ভাবন ও বিস্তার কর্মসূচি (জুলাই ২০১৯ - জুন ২০২২)	২৩৫.১৭	১৫.০০	১৫.০০	১০০%	১৫.০০ (৬%)
১৭.	বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউটের মৃত্তিকা বিজ্ঞান গবেষণাগার এ্যাক্রিডিটেশন কর্মসূচি (জুলাই ২০১৯ - জুন ২০২১)	৮৫৯.০০	২৬.০০	৭.৯২	৯০%	৭.৯২ (১%)
	সর্বমোটঃ	**৬২৪১.৮০**	**২৩৫৮.৪৮**	**২৩৪০.২৮**	**৯৯%**	**৪০৮৪.১৫ (৬৫.৪%)**

Table 6. Scheme to be implemented during 2020-2021

(লক্ষ টাকা)

ক্রমিক নং	কর্মসূচির নাম ও মেয়াদ	প্রাক্কলিত ব্যয়	২০২০-২১ অর্থবছরে বরাদ্দ
১.	উপকূলীয় অঞ্চলের লবণাক্ত জমিতে সূর্যমুখী উৎপাদন ও বিস্তার এবং সংগ্রহোত্তর প্রযুক্তি উদ্ভাবন কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	১৩৪.৯৪	৫৩.০৪
২.	চীনাবাদামের উন্নত জাত ও আন্তঃফসল প্রযুক্তি উদ্ভাবনের মাধ্যমে চরাঞ্চলের কৃষকদের পুষ্টি ও আর্থিক অবস্থার উন্নয়ন কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	৯৬.৫০	৪০.০০
৩.	বাংলাদেশে অর্কিড, ক্যাকটাস-সাকুলেন্ট, করম, বীজ, সাকার ও বাল্ব জাতীয় ফুলের জাত উন্নয়ন, উৎপাদন ও সংগ্রহোত্তর প্রযুক্তি উদ্ভাবন এবং বিস্তার কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	৩৪৬.০০	১৪৫.০০
৪.	উপকারী নভেল বেসিলাস ব্যাক্টেরিয়া দ্বারা উৎপাদিত জৈব পণ্য ব্যবহার করে বেগুনের ঢলে পড়া রোগ নিয়ন্ত্রণের প্রযুক্তি উদ্ভাবন ও বিস্তার কর্মসূচি (জুলাই, ২০১৮ - জুন, ২০২১)	২৮২.০০	৮৫.০০
৫.	জোয়ার ভাটা প্রবণ দক্ষিণাঞ্চলের পতিত জমিতে উদ্যানতাত্ত্বিক ফসলের উপযোগিতা যাচাই পূর্বক উৎপাদনশীলতা বৃদ্ধি (জুলাই ২০১৯ - জুন ২০২২)	১৭৮.৯৪	৯৫.১০
৬.	নিরাপদ ফল ও সবজির উৎপাদন এবং তাদের রপ্তানি বৃদ্ধিকরণ কর্মসূচী (জুলাই ২০১৯ - জুন ২০২২)	৬০৯.৩০	৪৪৫.৩০
৭.	বাংলাদেশের দক্ষিণাঞ্চলে চাষকৃত গুরুত্বপূর্ন ফল, পান, সুপারি ও ডাল ফসলের ক্ষতিকারক পোকামাকড় সনাক্তকরন ও সমন্বিত বালাই ব্যবস্থাপনার মাধ্যমে নিরাপদ ফসল উৎপাদন প্রযুক্তি উদ্ভাবন ও বিস্তার কর্মসূচি (জুলাই ২০১৯ - জুন ২০২২)	২৩৫.১৭	১৫১.০৭
৮.	বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউটের মৃত্তিকা বিজ্ঞান গবেষণাগার এ্যাক্রিডিটেশন কর্মসূচি (জুলাই ২০১৯ - জুন ২০২১)	৮৫৯.০০	৮৩৩.০০
	সর্বমোটঃ	**২৭৪১.৮৫**	**১৮৪৭.৫১**

Table 7. New Scheme sent to the MoA for further processing during 2020-2021

ক্র. নং	কর্মসূচির নাম	বাস্তবায়নকাল	সংশ্লিষ্ট কেন্দ্র ও বিভাগ	প্রাক্কলিত ব্যয়
১.	মিষ্টি আলুর প্রক্রিয়াজাতকরণ ও সংরক্ষণ কর্মসূচি	জুলাই ২০২০ - জুন ২০২৩	পোস্টহারভেস্ট টেকনোলজি বিভাগ, বিএআরআই, গাজীপুর	৯৯৮.০৭৫
২.	কচু ফসলের জিন পুল সমৃদ্ধ, গবেষণা, প্রযুক্তি উদ্ভাবন ও উন্নত জাত বিস্তার কর্মসূচি	জুলাই ২০২০ - জুন ২০২৩	কন্দাল ফসল গবেষণা কেন্দ্র, বিএআরআই, গাজীপুর	৯৯৭.৫১
৩.	উচ্চমূল্যের ফসল প্রবর্তণের মাধ্যমে কৃষির বাণিজ্যিকীকরণ স্কীম	জুলাই ২০২০ - জুন ২০২৩	সাইট্রাস গবেষণা কেন্দ্র, জৈন্তাপুর, সিলেট	১৫৪৬.২৫
৪.	আম, আনারস ও তরমুজ প্রক্রিয়াজাতকরণ ও সংরক্ষণ কর্মসূচি	জুলাই ২০২০ - জুন ২০২৩	পোস্টহারভেস্ট টেকনোলজি বিভাগ, বিএআরআই, গাজীপুর	৮৭৬.৩০
৫.	কাসাভা চাষে গবেষণা, প্রযুক্তি উদ্ভাবন ও বিস্তার কর্মসূচি	জুলাই ২০২০ - জুন ২০২৩	কন্দাল ফসল গবেষণা কেন্দ্র, বিএআরআই, গাজীপুর	৫৬৯.০০
৬.	বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট-এর কেন্দ্রীয় গবেষণাগারের গবেষণা কার্যক্রম উন্নয়ন কর্মসূচি	জুলাই ২০২০ - জুন ২০২৩	কেন্দ্রীয় গবেষণাগার, গবেষণা উইং, বিএআরআই, গাজীপুর	৮৭৩.৪৫
৭.	পাট চাষ ও প্রক্রিয়াজাতকরণে লাগসই কৃষি যন্ত্র উদ্ভাবন ও মাঠ পর্যায়ে উপযোগীতা যাচাই	জুলাই ২০২০ - জুন ২০২৩	এফএমপিই বিভাগ, বিএআরআই, গাজীপুর	১৬১.৫১
৮.	বসতবাড়িতে বছরব্যাপী শাক-সবজি ও ফল উৎপাদন পদ্ধতির মডেল উদ্ভাবন, উদ্ভাবিত মডেলসমূহের অভিযোজন পরীক্ষা এবং কমিউনিটি বেসড পাইলট প্রোডাকশন প্রোগ্রাম	জুলাই ২০২০ - জুন ২০২৩	সরেজমিন গবেষণা বিভাগ, বিএআরআই, গাজীপুর	৯৯৯.২৩
৯.	বাংলাদেশে শীতলপাটি শিল্পের উন্নয়নের লক্ষ্যে পাইলট কর্মসূচি	মে ২০২০ - জুন ২০২২	আঞ্চলিক কৃষি গবেষণা কেন্দ্র, রহমতপুর, বরিশাল	৮৯২.৮৫
১০.	উপকূলীয় অঞ্চলে বারি বীজ বপন যন্ত্রের বিস্তার ও যান্ত্রিক পদ্ধতিতে মুগ, ফেলন, সূর্যমুখী, সয়াবীন এবং চিনাবাদাম উৎপাদন	জুলাই ২০২০ - জুন ২০২৩	সরেজমিন গবেষণা বিভাগ, বিএআরআই, পটুয়াখালী	৬৭৫.৯৫
১১.	বাংলাদেশে গ্রীষ্মকালীন টমেটোর অভিযোজন পরীক্ষা, উৎপাদন প্রযুক্তি উদ্ভাবন ও কমিউনিটি বেসড পাইলট প্রোডাকশান প্রোগ্রাম	জুলাই ২০২০ - জুন ২০২৩	সরেজমিন গবেষণা বিভাগ, বিএআরআই, গাজীপুর	৯৯৯.২৭

Table 8. Other activities of Planning & Evaluation Wing during 2019-20

Sl. No.	Title	No. of Reports
১.	পরিকল্পনা ও মূল্যায়ন উইং এর বার্ষিক কর্মসম্পাদন চুক্তি (এপিএ) প্রণয়ন ও বাস্তবায়ন ২০১৯-২০	১
২.	পরিকল্পনা ও মূল্যায়ন উইং এর বার্ষিক কর্মসম্পাদন চুক্তির অগ্রগতির প্রতিবেদন (ত্রৈমাসিক, অর্ধবার্ষিক, বার্ষিক)	৪
৩.	SDGs এর আলোকে প্রতিষ্ঠানের কর্ম পরিকল্পনা প্রণয়ন ও অগ্রগতির প্রতিবেদন প্রণয়ন	১২
৪.	Monthly Progress Report (IMED 05/2008) of Development Projects	১২
৫.	এডিপিভূক্ত উন্নয়ন প্রকল্পসমূহের সময় নির্দিষ্ট কর্মপরিকল্পনা	১২
৬.	এডিপিতে অন্তর্ভূক্ত কৃষি মন্ত্রণালয়ের প্রকল্পসমূহের আর্থিক ও বাস্তব অগ্রগতি প্রতিবেদন	১২
৭.	একনেক সভায় উপস্থাপনের জন্য কৃষি মন্ত্রণালয়ের এডিপি/আরএডিপি'র অগ্রগতির তথ্য	১২
৮.	এডিপিভুক্ত প্রকল্পসমূহের উচ্চশিক্ষা, প্রশিক্ষণ সংক্রান্ত তথ্যাদির অগ্রগতি প্রতিবেদন	১২
৯.	উন্নয়ন প্রকল্পের কর্ম ও ক্রয় পরিকল্পনা প্রণয়ন	২
১০.	উন্নয়ন প্রকল্পসমূহের ক্রয় পরিকল্পনার বাস্তবায়ন অগ্রগতি প্রতিবেদন	১২
১১.	এডিপি বাস্তবায়ন অগ্রগতি সম্পর্কিত প্রকল্প ভিত্তিক প্রতিবেদন	১২
১২.	Quarterly Progress Report (IMED 02-03/2008) of Development Projects	৪
১৩.	বার্ষিক উন্নয়ন কর্মসূচি (এডিপি) প্রণয়ন	১
১৪.	সংশোধিত বার্ষিক উন্নয়ন কর্মসূচি (আরএডিপি) প্রণয়ন	১
১৫.	মধ্যমেয়াদী বাজেট কাঠামোর (MTBF) আওতায় ২০১৯-২০ অর্থ বছরের ব্যয়ের প্রাক্কলন এবং ২০২০-২১ থেকে ২০২১-২২ অর্থ বছর পর্যন্ত প্রক্ষেপণ	২
১৬.	বাজেট বাস্তবায়ন পরিকল্পনা (ফরম-গ.২) প্রণয়ন এবং বাস্তবায়ন অগ্রগতি পরিবীক্ষণ প্রতিবেদন	৪
১৭.	কার্যক্রমসমূহ, ফলাফল নির্দেশক এবং নির্দেশকের (Key Performance Indicators) লক্ষ্যমাত্রা ও মাসিক অগ্রগতির প্রতিবেদন	৪
১৮.	রাজস্ব বাজেটের আওতায় বাস্তবায়নাধীন কর্মসূচিসমূহের অগ্রগতি প্রতিবেদন	১২
১৯.	রাজস্ব বাজেটের আওতায় বাস্তবায়নাধীন কর্মসূচিসমূহের প্রশিক্ষণ সংক্রান্ত প্রতিবেদন	১২
২০.	রাজস্ব বাজেটের আওতায় বাস্তবায়নাধীন কর্মসূচিসমূহের ক্রয় সংক্রান্ত অগ্রগতি প্রতিবেদন	১২
২১.	রাজস্ব বাজেটের আওতায় বাস্তবায়নাধীন কর্মসূচিসমূহের মনিটরিং প্রতিবেদন	৪
২২.	৭ম পঞ্চবার্ষিক পরিকল্পনা ২০১৬-২০২০ (Seventh Five Year Plan) সংক্রান্ত প্রতিবেদন প্রণয়ন	১
২৩.	বিএআরআই এর ৮ম পঞ্চবার্ষিক পরিকল্পনা ২০২১-২০২৫ (Eight Five Year Plan) প্রণয়ন	১
২৪.	বার্ষিক উন্নয়ন কর্মসূচি (এডিপি) প্রণয়নের লক্ষ্যে বৈদেশিক সাহায্যপুষ্ট প্রকল্পসমূহের প্রকল্প সাহায্য বরাদ্দ প্রাক্কলন	১
২৫.	মাননীয় প্রধানমন্ত্রী কর্তৃক প্রদত্ত নির্দেশনা বাস্তবায়ন অগ্রগতি প্রতিবেদন	১২
২৬.	জেলা প্রশাসক সম্মেলন ২০১৭-এর উদ্বোধন অনুষ্ঠানে মাননীয় প্রধানমন্ত্রী কর্তৃক প্রদত্ত নির্দেশনা বাস্তবায়ন।	১২

Future Plan

List of Future Projects in RelatnMm to SDGs (2021-2030) beyond 7th FYP & 8th FYP

1. Expansion of homestead gardening, school gardening commercial fruit gardening as a source of nutritional security all year round.
2. Expansion of appropriate post harvest management technologies (Processing, preservation & packaging) to reduce production loss and develop market linkage among the producer and consumer.
3. Production & distribution of good quality seed
4. Increase agricultural productivity or production through modern technology transfer, minimizing yield gap, crop diversification & intensification with high value crop production.
5. Extension of appropriate post harvest management technologies through training and demonstration
6. Increase water use efficiency through improved on-farm water management technologies such as AWD, Dug well, Buried Pipe, Hose Pipe, Raised Bed rice irrigation, Drip & Sprinklers irrigation, Hand shower irrigation, Mulching etc.
7. Introduction of renewable energy to provide irrigation.
8. Research and Extension of Vegetables and Spices Cultivation on Floating Bed
9. Integrated Agricultural Research & Development Project in South West part of Bangladesh
10. Soil management through organic and inorganic amendments
11. Development of climate smart crop varieties and Seed
12. Development of stress tolerant (Salinity, drought, water submergence, cold, heat, etc and diseases, insect resistant) high yielding major crop varieties.
13. Seed production and supply of climate resilient crop varieties.
14. Collection, preservation and maintenance of plant genetic resources for food and agriculture for medium or long-term conservation.
15. Morphological and molecular characterization of the collected genetics resources.
16. Enhancement of pulse research and extension at greater Faridpur and southern region of Bangladesh
17. Strengthening of Spices Crop Research in Bangladesh
18. Tuber Crops Research Strengthening Project
19. Established value chain development for vegetables, fruits by encouraging public-private partnership (PPP)
20. Biotechnological and hybrid research capacity development.
21. Development of Nutrient enriched and Biotic stress tolerant crop varieties
22. Manpower development (PhD, MS, Short/long duration training, etc)
23. Strengthening of ICT for effective and rapid technology transfer.
24. Extension of Biotic stress tolerant crop varieties

Projects beyond 7th FYP Period (2021-2030) aligning with SDGs

1. Development and extension of cereals, vegetables, fruits, pulses, oilseed and tuber crops with nutrient enriched varieties.
2. Extension and expansion of bio-rational based IPM/IDM, INM GAP, Biopesticides approaches and organic agriculture
3. Development of high yielding, hybrid and transgenic crop varieties.
4. Promotion of organic and safe food production for human
5. Enhancement of crop production through Farm Mechanization
6. Enhance Integrated Agricultural Productivity Approach
7. Introduction of water saving technologies such as, drip irrigation, sprinkler

irrigation, furrow irrigation, alternate furrow irrigation, deficit irrigation, etc. at farmers levels

8. Improvement and extension of the existing cropping pattern and crop zoning to increase productivity
9. Women empowerment in production, processing & other income generating activities.
10. Expansion of appropriate post harvest management technologies (Processing, preservation & packaging) to reduce production loss and develop market linkage among the producer and consumer.
11. Increase agricultural productivity or production through modern technology transfer, minimizing yield gap, crop diversification & intensification with high value crop production.
12. Production & distribution of good quality seed
13. Increase water use efficiency through improved on-farm water management technologies such as AWD, Dug well, Buried Pipe, Hose Pipe, Raised Bed rice irrigation, Drip & Sprinklers irrigation, Hand shower irrigation, Mulching etc.
14. Development of small farm tools and machinery
15. Introduction of renewable energy to provide irrigation.
16. Popularization/Extension of environment friendly green technologies (e.g. GAP, IPM, INM, AWD, Dry seed bed, bio pesticides, organic agril. etc.)
17. Extension of climate smart soil and fertilizer management and climate smart crop varieties.
18. Emphasis on extension work to mitigate stress condition like drought, salinity, submergences, flooding & other disasters
19. Soil management through organic and inorganic amendments
20. Increase use of rural & urban organic wastages, waste water and crop residues for renewable energy (biogas) and bio-pesticides instead of chemical pesticides.
21. Development of climate smart crop varieties and Seed
22. Development of stress tolerant (Salinity, drought, water submergence, cold, heat, etc and diseases, insect resistant) high yielding major crop varieties.
23. Emphasis on research and development work to mitigate stress, condition like drought, salinity, submergences, flooding & other disasters
24. Seed production and supply of climate resilient crop varieties.
25. Increase use of rural & urban organic wastages, waste water and crop residues for renewable energy (biogas) and bio-pesticides instead of chemical pesticides.
26. Collection, preservation and maintenance of plant genetic resources for food and agriculture for medium or long-term conservation.
27. Morphological and molecular characterization of the collected genetics resources.
28. Biotechnological and hybrid research capacity development.
29. Development of Nutrient enriched and Biotic stress tolerant crop varieties
30. Strengthening research facilities for HQ and outreach stations.
31. Establishment of new research station/centre under.
32. Manpower development (PhD, MS, Short/long duration training, etc)
33. Strengthening of ICT for effective and rapid technology transfer.
34. Strengthening Research-Extension-Education-Farmers linkage among SAARC countries & international organizations.
35. Encourage Public-Private Partnership (PPP) for agricultural development in value chain development/agro-processing/Food processing/farm mechanization.
36. Extension of Biotic stress tolerant crop varieties.

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. 17961.36 lakh. The GoB funding was Tk. 17961.36 lakh, which was offered by different aid-giving agencies as Project Aid (PA).

Besides, an amount Tk. 26264.01 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 2019-2020 (in lakh Tk.)

Total	GOB Head			Project Aid (PA/RPA	Expenditure		Total
	ADP	Revenue	Total		ADP	Revenue	
44490.37	17961.36	26264.01	44225.37	265.00	15494.42	26161.05	41655.47

Table-2: Development Budget (Annual Development Programme) of BARI for 2019-2020 (in lakh Tk.)

No.	Name of Projects & Programs	Total	GOB		PA/RPA	Expenditure		Total
			Revenue	Capital		Revenue	Capital	
	A. Development Projects							
1.	Improvement and Quality Seed Production of Wheat and Maize-2nd Phase	**271.00**	271.00	0	0	269.56	0	**269.56**
2.	Strengthening of Oilseed and Pulses Research and Development in Bangladesh	**278.00**	278.00	0	0	273.00		**273.00**
3.	Strengthening Research on Horticultural Crops and Dissemination of Horticultural & Field Crop Technology at Charland Areas	**1065.00**	913.00	152.00	0	910.68	149.88	**1060.56**
4.	Research, Extension and Popularize of Vegetables and Spices Cultivation on Floating Bed	**554.00**	551.00	3.00	0	551.00	3.00	**554.00**
5.	Development and expansion of bio-rational based integrated pest management of vegetables, fruits and betel leaf (January 2018 to December 2021)	**521.00**	388.00	133.00	0	318.00	133.00	**451.00**

No.	Name of Projects & Programs	Total	GOB		PA/RPA	Expenditure		Total
			Revenue	Capital		Revenue	Capital	
6.	Strengthening of Spices Crop Research in Bangladesh	**2272.00**	820.00	1452.00	0	801.00	1452.00	**2253.00**
7.	Establishment of Agriculture Research Station, BARI, Gopalganj and eco-friendly agricultural development project in south-western part through strengthening of research	**10102.00**	405.00	9697.00	0	376.49	7290.74	**7667.23**
8.	Upgrading Regional Horticulture Research Station, Cumilla to Regional Agricultural Research Station	**489.00**	109.00	380.00	0	109.00	250.00	**359.00**
9.	Smallholder Agricultural Competitiveness Project (SACP) (BARI Part)	**334.00**	42.00	27.00	265.00	145.17	131.54	**276.71**
Sub-Total -A Development Projects:		**15886.00**	**3777.00**	**11844.00**	**265.00**	**3753.90**	**9410.16**	**13164.06**

Table-3: Non Development Budget (Annual Programs) of BARI for 2019-2020 (in lakh Tk.)

No.	Name of Projects & Programs	Total	GOB		PA	Expenditure		Total
			Revenue	Capital		Revenue	Capital	
	B. Programs							
1.	Khesari, Blackgram, Felon Variety development, seed production and post harvest technology innovation and dissemination program.	**110.00**	110.00	0	0	100.00	0	**100.00**
2.	Program on varietal improvement and technology development research of black pepper, black cumin and cumin with other nonconventional spice crops.	**90.72**	54.97	35.75	0	54.97	35.75	**90.72**
3.	Processing and Preparation of Vegetable Meat from Green jackfruit.	**127.86**	53.88	73.98	0	53.88	73.98	**127.86**
4.	Improvement of local mango variety, development of production and distribution of mother prop gules of BARI developed promising varieties	**210.00**	210.00	0	0	210.00	0	**210.00**
5.	Development and extension of four crop based cropping pattern to increase cropping intensity program.	**150.00**	150.00	0	0	150.00	0	**150.00**
6.	Strengthening of nonconventional of crops research (soyabean, sunflower and linseed).	**140.00**	140.00	0	0	140.00	0	**140.00**

No.	Name of Projects & Programs	Total	GOB		PA	Expenditure		Total
			Revenue	Capital		Revenue	Capital	
7.	Programme for the Production of Onion Breeder Seed.	**45.00**	45.00	0	0	45.00	0	**45.00**
8.	Programme for the Processing and Preservation of Green Mango.	**23.98**	23.98	0	0	23.98	0	**23.98**
9.	Production, Dissemination and postharvest Technology Development of Sunflower for Saline lands of Coastal Region.	**66.88**	60.00	6.88	0	60.00	6.88	**66.88**
10.	Enhancement of nutritional status and economic condition of charland farmers through development of modern groundnut varieties and intercropping technologies.	**41.48**	41.48	0	0	41.48	0	**41.48**
11.	Program on Varietal Development, Production and Postharvest Technology of Orchid, Cactus-Succulent, Corn and Bulbous flower and their Dissemination in Bangladesh.	**156.00**	45.00	111.00	0	45.00	111.00	**156.00**
12.	Innovation and dissemination of formulated bio-product from novel endophytic Bacillus species for controlling witing of eggplant	**197.00**	90.00	107.00	0	90.00	107.00	**197.00**
13.	Accreditation of Plant Pathology Laboratory at Bangladesh Agricultural Research Institute	**927.44**	108.99	818.45	0	108.99	818.45	**927.44**
14.	Increasing Productivity of Horticulture Crops in Fallow Land of Tidal Prone Southern Region through Validation Trials	**12.00**	12.00	0	0	12.00	0	**12.00**
15.	Production of Safe Fruits and Vegetables and Promotion of Their Exports	**19.00**	11.00	8.00	0	11.00	8.00	**19.00**
16.	Program on Accreditation of soil Science Laboratory of Bangladesh Agricultural Research Institute	**8.00**	8.00	0	0	8.00	0	**8.00**
17.	Documentation of Insect Pests, Development and Desimination of Integrated Pest Management Technology for cultivating Important Fruits, Betedl Leaf, Betel Nut and Pulse Crops through Safe Food Production in Southern Region of Bangladesh	**15.00**	15.00	0	0	15.00	0	**15.00**
Sub-Total -B Programs:		**2340.36**	**1179.30**	**1161.06**	**0**	**1169.30**	**1161.06**	**2330.36**
Grand Total (A+B):		**18226.36**	**4956.30**	**13005.06**	**265.00**	**4923.20**	**10571.22**	**15494.42**

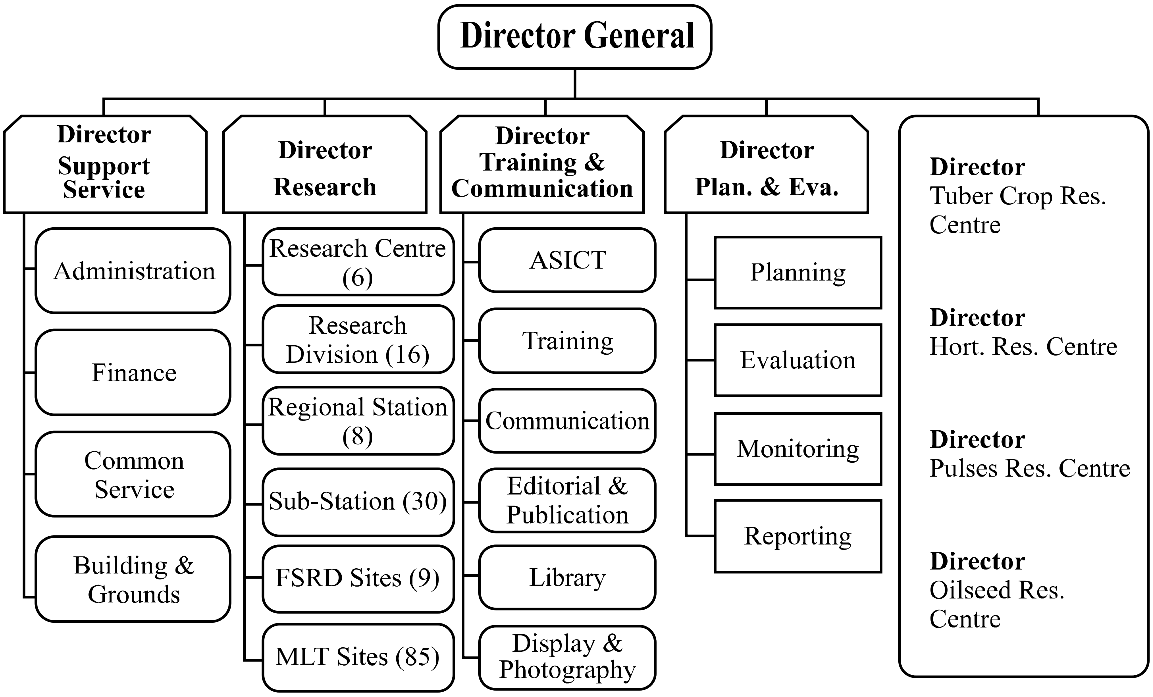
28
INFORMATION REPORT
(As per Information Commission Requirements)

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 four directors of its four major wings such as Research Wing, Support Service Wing, Training & Communication Wing and Planning & Evaluation Wing. The research Wing executes and monitors all the research programs and other research activities through 6 special crop research centers, 16 research divisions, 8 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. The Panning & Evaluation Wing is responsible for developing, executing, monitoring, evaluation of different projects.

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, 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 four directors: Director (Research), Director (Support Service), Director (Training & Communication) and Director (Planning & Evaluation).

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.

Director (Support Service) is responsible for personal management, finance & accounts, procurement, infrastructure development, security, transportation and repair & maintenance.

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.

Director (Panning & Evaluation) is responsible for developing, executing, monitoring, evaluation of different projects under development budgets and Programmes (Karmosuchi) under revenue budget of GoB with the help of crop centers, sub-centers, divisions, Regional Agricultural Research Station (RARS) and Agricultural Research Station (ARS). Also involves in financial management, procurement activities, infrastructure development and arrange meetings like Project Implementation Committee (PIC), Project Evaluation Committee (PEC) of different projects and Planning & Development Committee (P&DC) meeting of the institute.

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 hand, 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	: Chief Scientific Officer (CSO)
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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
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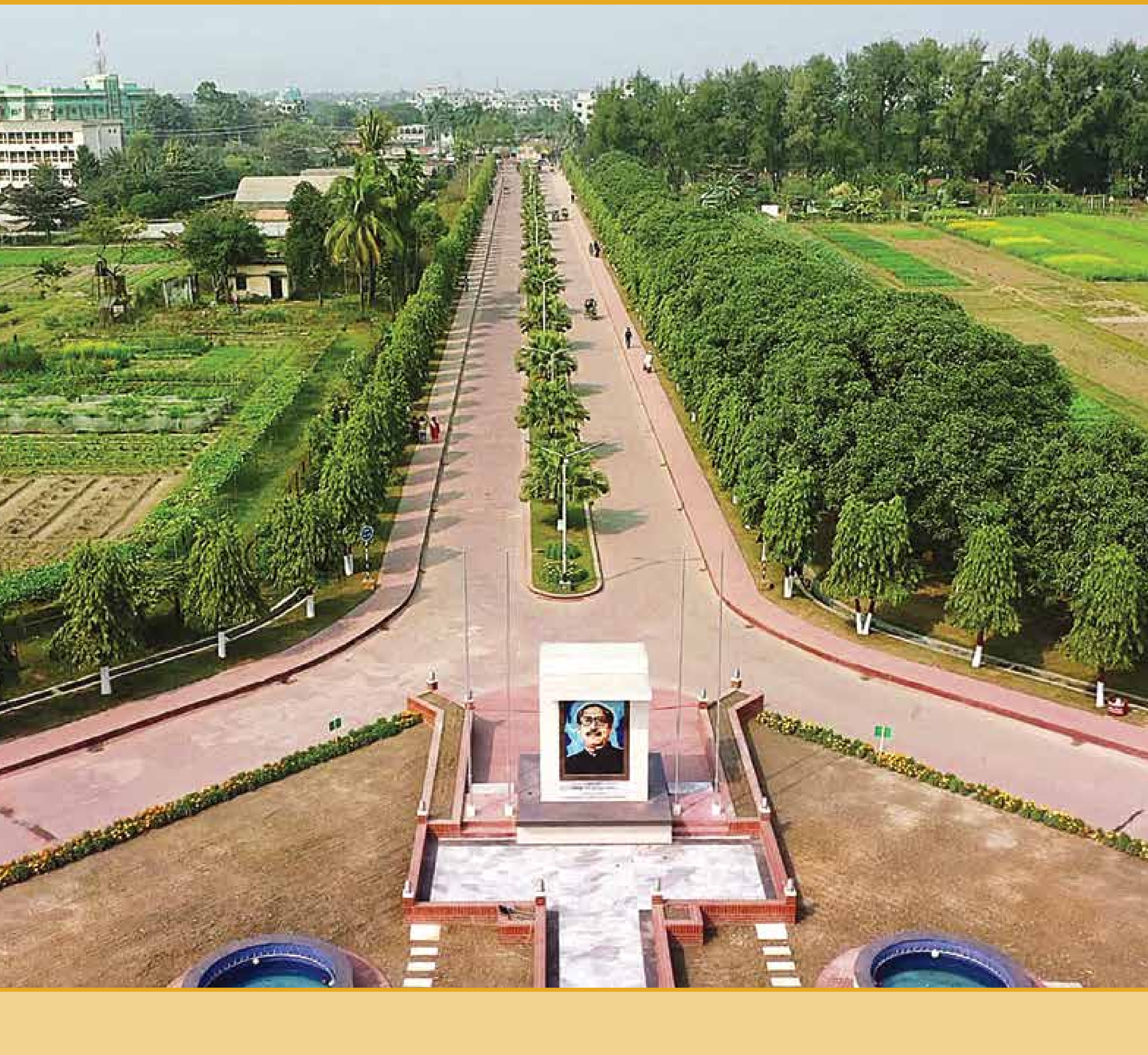
Website	: www.bari.gov.bd
Office	: Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

Designated Officer (Appeal)	
Officer's name	: Md. Nasiruzzaman মো. নাসিরুজ্জামান
Designation	: Secretary
Phone	: 9540100
Mobile	: 01730-592056
Email	: secretary@moa.gov.bd
Website	: www.moa.gov.bd
Office	: Ministry of Agriculture (MoA), Dhaka

List of Information delivery to the citizen during 2019-20

ক্রমিক নং	কর্তৃপক্ষের নাম	তথ্য অধিকার আইন, ২০০৯ এর ফরমেট অনুযায়ী তথ্য সরবরাহের জন্য প্রাপ্ত আবেদনের সংখ্যা	তথ্য সরবরাহের মাধ্যমে নিস্পত্তিকৃত আবেদনের সংখ্যা	অনুরোধকৃত তথ্য না দেয়ার সিদ্ধান্তের সংখ্যা ও উক্ত সিদ্ধান্তগ্রহণের কারণ	দায়িত্বপ্রাপ্ত কর্মকর্তার সিদ্ধান্তের বিরুদ্ধে আপীলের সংখ্যা	আপীল নিস্পত্তির 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 পরিমান	কর্তৃপক্ষ কর্তৃক গৃহীত বিভিন্ন কার্যক্রমের বিবরণ	এন্তব্য
১	২	৩	৪	৫	৬	৭	৮	৯	১০	১১
১	বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট, গাজীপুর	২৫২ *৪টি (তথ্য কমিশনের ফরমেট অনুযায়ী) *২৪৮টি (বিএআরআই এর ওয়েব পোর্টাল ও মোবাইল অ্যাপস হতে প্রাপ্ত ই-কৃষি সংক্রান্ত তথ্যের প্রশ্ন সংখ্যা)	২৫২ *৪টি (তথ্য কমিশনকে জানানো হয়েছে) *২৪৮টি (বিএআরআই এর ওয়েব পোর্টাল ও মোবাইল অ্যাপস হতে প্রাপ্ত ই-কৃষি সংক্রান্ত তথ্যের উত্তর সংখ্যা)	-	-	-	-	-	-	-



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