Research Highlights
2014 - 2015

A. Characterization & Maintenance of Germplasm

Maintenance and seed increase of promising inbred lines of maize

Seventy one new exotic inbred lines (set-I: 45 and set-II: 26) from CIMMYT and six existing lines (Set III: 6) were maintained through selfing to increase seedsfor using in future breeding program.

B. Development of Source Popular &Inbred lines

Recycling for development of maize inbred lines

Superior inbred lines are desirable for the development of better hybrids. In order to develop superior inbred line(s), the commercial hybridIM8013 was advanced to S_1 generation from S_o and 40 selfed ears (S_1) were selected& presented next generation advancing.

Advancing $S_1$to S_7 generation of field corn, pop corn and baby corn (27 Sets)

Inbred lines of maize are prerequisite for the development of hybrids. Extraction of superior inbred lines through recycling is acommon technique in maize breeding. The balanced bulk seeds of S_1 field corn lines, Set I:Titan, Set II: 9120, Set III: 50 S_1 lines of base population(early and dwarf), Set IV : 50 S_1 lines of base population(medium height and high yield goal) and Set V:American pop corn, were advanced to S_2 generation and 45, 40, and 80 selfed ears collectedfrom Titan, 9120, American pop corn, respectively and one cob from each S_1 line for50 S_2lines of base population(early and dwarf; medium height& high yield) were selected& preserved separately for advancing them to next generation.

The balanced bulk seeds of S_2 field corn lines of six sets (Set I: Pinacle, Set II: 981,Set III:Arun 4, Set IV: Seeds New, Set V: BARI Sweet corn 1 and Set VI: Pop corn Nepal) were advanced to S_3 generation. Variations were found among the S_2 lines for different traits. Finally 55, 44, 121, 39, 35 and143 selfed S_3 ears form the above respective S_2 generation were preserved for advancing them to S_4 generation for developing test crosshybrids.

Twenty eight S_3 lines of commercial hybrid 981and pioneer were advanced to S_4 generation following ear to row method. Variations were found among the lines for different traits. Total 103 and 95 selfedears were selected for next generation advancing.

Two sets of S_4 Baby corn hybrids*viz.* Victory super(36 S_4lines) and KH101 (39 S_4lines), two sets of Popcorn varieties *viz*. Thai popcorn(18 S_4lines) and Popcorn burst(20 S_4lines) and one set of field corn hybrid7074(28 S_4lines) were advanced to S_5 generation in order to develop superior inbred line(s)following ear to row method.Variations were found among the S_4lines. Selected plants were selfed and S_5 seeds were preserved for advancing them to S_6 generation.

Seven sets of S_5 lines of field corn hybridsviz. SetI: 900 M Gold (19 lines), Set II: Pacific-60 (15 lines) and Set III: Uttaran-2 (20 lines) and Set IV: Pinacle(30 lines), Set V:QY 11 (27 lines), Set VI: Wang 11(32 lines), Set VII:NT6323(30lines),one set of baby corn BCP-

271(31lines) and one set of pop cornhybridPop-P622 (15 lines) were advanced to S_6 generation following ear to row method. The plants were seemed to be mostly uniform in height. Selected S_5 plants were selfed and finally selected crosses were preserved for next generation advancing.

This is the final stage of inbred development through recycling. In this generation, thirteen S_6 lines of NK46 were advanced to S_7 generation in order to develop superior inbred line(s)following ear to row method. There was no variation among the plants and those weresupposed to attain honozygosity. These fully developed inbred lines will be used in hybrid development.

C. Evaluation of Inbred Lines Through Line× Tester Method and North Carolina Design II

(i) Evaluation of inbred lines of maize through line × tester method *(8 sets)*

Field corn:

In set I,SevenS_3 lines of commercial hybrid 7074 were crossed with 3 testers in a Line × Tester mating design and the resulting 21 crosses along with the parents and standard check BHM 9 and NK 40 were evaluated in alpha lattice design with two replications at Gazipur. Among the line parents,7074/S_3-1, 7074/S_3-5, 7074/S_3-8 and 7074/S_3-11 and testers BML-36 and CML-425 were good general combiners for grain yield and some of the important yield contributing characters. Three crosses (7074/S_3-1×BML-36, 7074/S_3-5×CML-425, 7074/S_3-8×CML-425) showed high scaeffects & high mean performances (11.93-13.83 t/ha)for yield could be used for commercial hybrid development.

In set II, Nineteen lines were crossed with 2 testers in a Line × Tester mating design to produced38 crosses. All the crosses along with the parents and standard checks BHM 9 were evaluated in alpha lattice design with two replications. The parents E7, E10, E15 and E19 could be used in hybridization program as donor. Better performing three crosses (E14×BIL95, E17×BIL79 and E4×BIL95)showed high heterosis over check &also had high mean yield (10.44-12.55 t/ha) were selected to evaluate in multilocation trial.

In set III, the experiment was conducted with 10S_4 lines crossed with 3 testers in a Line × Tester mating design and the resulting 30 crosses along with the parents evaluated in alpha lattice design with three replications at RARS Rhamatpur, Barisal. The inbred parents SP10, SP4, and SP8 were found as the good general combiner for yield. Two crosses P2×BIL-106, P5×BIL-110 and P6×BIL-28showed high mean yield (12.91-15.70t/ha) were identified as the best combinations.

In Set IV, 26 S_4 lines of commercial hybrid 'Pinacle' were crossed with 3 testers in a Line × Tester method and the resulting 78 crosses along with parents and two checks (BHM 9 and NK40) were evaluated in alpha lattice design with two replications at Gazipur.Eight lines viz. Pinacle/S_4-1, Pinacle/S_4-2, Pinacle/S_4-5, Pinacle/S_4-6, Pinacle/S4-15, Pinacle/S_4-19, Pinacle/S_4-28 and Pinacle/S_4-30 were found good combiner for grain yield. Three crosses Line 15×BIL 79, Line 5×BIL 79 and Line2×BIL 106 showed high SCA, high heterosis (7.46-12.30% over check NK40)& high mean yield (13.11-13.70 t/ha) were selected as the best combinations. These crosses could be utilized for commercial hybrid after verification.

Pop corn:

In Set VI, Eight S_3 lines of Thai pop corn were crossed with 3 testers in a Line × Tester mating design. The resulting 24 crosses along with two checks (NI5820 and Khoibhutta) were evaluated in alpha lattice design with two replications at Gazipur. The predominance of non-additive gene action for useful traits suggested the improvement of the trait though heterosis breeding. Interaction contributed minimum for both yield and quality traits to total variance. The lines Thai Pop/S_3-28 and Thai Pop/S_3-20 were identified as the good general combiners for popping quality. The good combination crosses were Thai pop/S_3-1×PCB/S_6-13, Thai pop/S_3-17×PCB/S_6-39 and Thai pop/S_3-20×PCB/S_6-39showed high mean grain yield (5.43-6.89 t/ha) and quality traits like popping percentage (95.5-96.0%), popping expansion (16.11- 30.81) and had good taste of quality could be used in future breeding program to develop high yielding popcorn hybrids after their verification.

Baby corn:

In set V, Seven S_4 lines of baby corn hybrid BCP-271 were crossed with 3 testers in a Line × Tester mating design and the resulting 21 crosses along with parents and standard check 'Baby star' were evaluated in alpha lattice design at Gazipur. Results showed that both additive & non-additive gene effects were important for controlling the trials. Interaction for both fodder & baby corn yield contributed maximum to the total variance. Among the lines BCP/S_4-29 and BCP/S_4-31, and testers VS/S_3-1 and VS/S_3-26 were found good general combiners for baby corn yield. Five crosses BCP/S_4-2×VS/S_3-1, BCP/S_4-5×VS/S_3-8, BCP/S_4-10×VS/S_3-8, BCP/S_4-22×VS/S_3-26 and BCP/S_4-29×VS/S_3-1produced higher number of cobs (4 cobs/plant) and shorter harvest duration (6 to 9 days) were selected for further verification.

In set VII, a Line × Tester analysis was conducted in baby corn involving 8 selected S_3 lines and 3 testers. The produced 24 F_1's along with parents and one check 'Babystar' were evaluated in alpha lattice design with two replications at Gazipur. The lines KH-101/S_3-1, KH-101/S_3-39 were identified as the good general combiner for cobs/plants. Three crosses KH-101/S_3-39×VS/S_3-24, KH-101/S_3-44×VS/S_3-24 and KH-101/S_3-32×VS/S_3-24 showed average 3-4 baby cobs/plant, high green fodder yield 874-937 g/plant and baby cob picking duration (9-12 days) were selected for further verification.

In set VIII, a Line × Tester analysis was conducted in babycorn involving 6 S_3selected lines and4 testers. The resulting 24 F_1's along with parents and one check 'Baby star' were evaluated in alpha lattice design with two replications at Gazipur. The number of baby cobs/plants contributed maximum for lines, whereas interaction of lines and testers contributed maximum to total variance for baby cobs picking duration.LinesKH-101/S_3-3 and KH-101/S_3-4 have been identified as the best general combiner for baby cobs/plant and baby cobs picking duration. ThreecrossesKH-101/S_3-13×VS/S_3-7, KH-101/S_3-13×VS/S_3-10 and KH101/S_3-25×Vs/S_3-10 were found promising for high fodder yield (0.56 to 1.31kg/plant),early harvesting (85-89 days), average 3 baby cobs/plant and short harvesting duration (10-12 days).

(ii) Evaluation of inbred lines of maize through North Carolina Design II *(4 sets)*

Field corn:

In set I, Twenty five field corn hybrids produced through North Carolina Design II (NCD II) involving 5 male and 5 female lines were evaluated in alpha lattice design with two replications at Gazipur. Results showed that non-additive gene action was predominant in controlling the traits. Line 900MG/S_4-4 and testers 9MS/S_6-16 had high mean and positive GCA for grain yield. Four crosses900MG/S_4-12×9MS/S_6-4, 900MG/S_4-12×9MS/S_6-5, 900MG/S_4-22×9MS/S_6-4 and 900MG/S_4-22×9MS/S_6-16showed positive SCA with high mean yield (11.33-13.14t/ha)along with minimum lodging damage and low ear height (60-76cm)could be used for hybrid development.

In set II, Twenty five field corn hybrids were produced following North Carolina Design II (NCD II) were evaluated along with parents in alpha lattice design with two replications at Gazipur. Four lines Pac60/S4-3, Pac60/S4-21, Utn2/S4-15 and BIL113 had positive GCA and higher mean yield. Considering lodging tolerance and higher yield (12.18-13.74 t/ha), five crosses (Pac-60/S4-3×BIL-113, Pac-60/S4-21×BIL-113, Pac-60/S4-9×Utn2/S4-15, Pac-60/S4-21×Utn2/S4-10andPac-60/S4-21×Utn2/S4-15)could be used for hybrid development.

In set III, North Carolina Design II (NCD II) involving 5 female and 5 male resulting 25 crosses were evaluated along with the parents in alpha lattice design with two replications at Gazipur. Inbred lines QY11/S_4-14,QY11/S_4-30, 9MS/S_6-10 and 9MS/S_6-15 were good combiner exhibiting significant positive GCA for yield and lodging tolerance ability. Considering lodging tolerance, dwarfness with high yield, 8 crosses (7074/S_3-15×9MS/S_6-10, QY11/S_4-14×9MS/S_6-2, QY11/S_4-14×9MS/S_6-10, QY11/S_4-14×9MS/S_6-14, QY11/S_4-14×9MS/S_6-15, QY11/S_4-30×BIL-113, QY11/S_4-30×9MS/S_6-4 and QY11/S_4-30×9MS/S_6-10) having high yield (13.15-14.80 t/ha) with dwarf plants(161-169cm) and low ear height (61-72cm) could be used for developing lodging tolerance dwarf hybrids with high yield.

Pop corn:

In set IV,The study was conducted following North Carolina matting deign II involving 5 female and 5 male lines. The resulting 25 crosses along with the parents were evaluated in alpha lattice design with two replications at Gazipur. The parent lines P622/S_4-33, PCB/S_3-34and PCB/S_3-39 had good GCA for yield and quality traits. Three crosses P622/S_4-14×PCB/S_3-34,P622/S_4-37×PCB/S_3-40 and P622/S_4-39×PCB/S_3-34 showed higher grain yield (4.25-4.99 t/ha) along with the popping quality traits like popping percentage (95-97%), popping expansion (21-30) could be used for hybrid pop corn development.

D: Combining Ability and Heterosis Study:

Combing ability and heterosis studies in maize *(2 Sets)*

In set I, 21 F_1's produced through 7×7 diallel mating design excluding reciprocals were evaluated along with 3 commercial hybrids viz. BHM-9, 900MGold and NK40 following alpha lattice design with 3 replications in three different environments viz. Gazipur, Jessore and Ishurdi. Among the parents P_5 and $P_7$was found as the best general combiner for high

yield; P_1, P_2, P_3 and P_4 for earliness;.and P_2, P_3 and $P_4$for dwarf plant type. The cross $P_5 \times P_7$produced the highest grain yield (13.31 t/ha) as well as the highest heterosis (5.64%),it showed non-significant and but positive SCA effect for the same trait. Six crosses ($P_5 \times P_7$, $P_5 \times P_6$,$P_2 \times P_5$, $P_4 \times P_5$,$P_4 \times P_7$, $P_6 \times P_7$ and $P_1 \times P_5$) showed high mean yield (11.39-13.31 t/ha)could be utilized for developing high yielding hybrids as well as for exploiting hybrid vigour.

In set II, 7 inbred lines crossed in a 7×7 diallel mating design excluding reciprocals and the resulting 21crossesalong with 3 commercial hybrids viz. BHM7, NK40 and Pioneer 30V92 were evaluated in alpha lattice design with two replications at Gazipur. Parents P_1 and P_6were good combiner for yield,P_1 and P_3 was good combiner for earliness, P_5 for short plants and P_1, P_4 and P_6 for longer ears, and bold grain. The highest heterosis 13.03% was exhibited by the cross $P_3 \times P_6$ followed by $P_2 \times P_4$ (9.92%). Three crosses $P_3 \times P_6$, $P_2 \times P_4$and $P_5 \times P_6$ showed high mean yield(12.44-13.45 t/ha) as well as higher heterosis (4.54-13.03%) could be utilized for high yielding hybrid variety development.

E: Evaluation of Single Cross, Modified Single Cross &Double Cross Hybrids

(i) Evaluation of single cross maize hybrids *(3 Sets)*

Field corn:

In set I, Thirteen locally developed single cross field corn hybrids were evaluated along with two commercial checks 900M and BARI hybrid maize 9 in RCBD with two replications at Gazipur. Three hybrids 9MG/S_4-17×9MS/S_6-4,9MG/S_4-9×Pac60/S_4-19 &9MG/S_4-10×Pac60/S_4-19 showed high mean yield (12.09-13.64 t/ha)along with lodging tolerance were selected for further evaluation at different locations for hybrid variety development.

Baby corn:

In set II, Thirty five locally developed single cross baby corn hybrids were evaluated along with a commercial check 'Baby star' in alpha lattice design with 2 replications at Gazipur. Fourteen baby corn hybrids were selected for utilizing high yielding quality hybrid variety development based on number of cobs per plant (4-5 cobs/plant), lower duration of pickingbaby cob harvesting (7-12 days), green fodder yield (574-909 g/plant) and baby cobs yield without husk(23.2- 39.2 g/plant).

In set III,Thirty three locally developed single cross baby corn hybrids were evaluated along with the commercial check 'Baby star' in alpha lattice design with 2 replications at Gazipur. Considering earliness (78-82 days), number of cobs/plant (3.43-3.70) with little bit lower harvesting duration of baby cobs (7.3-13.7 days) 5 crosses KH-101/S_3-28×KH-101/S_3-14, KH-101/S_3-36×KH-101/S_3-31, KH-101/S_3-14×KH-101/S_3-5,KH-101/S_3-17×KH-101/S_3-20 and KH-101/S_3-1×KH-101/S_3-2 were selected for utilizing high yielding quality baby corn hybrids after verification.

(ii) Evaluation of modified single cross hybrid maize *(5 Sets)*

Field corn:In set I, Twenty five modified single cross field corn hybrids were evaluated in alpha lattice design with two replications at Gazipur to select high yielding desirable hybrids.

Three hybrids (9MG/S_3-2×9MG/S_3-4)×Pac60/S_4-19, (9MG/S_3-11×9MG/S_3-3)×900MS/S_6-9 and (9MG/S_3-11×9MG/S_3-6)×Pac60/S_4-19were found promising for high yield (13.3 to 14.8 t/ha), lodging tolerant and medium tall plants could be utilized for hybrid development.

In set II, Twenty-two locally developed modified single cross field corn hybrids and a check BARI hybrid maize 9 were evaluated in alpha lattice design with two replications at Gazipur to select high yielding desirable hybrids. Hybrids (Utn-2/S_3-8×Utn-2/S_3-18)×Pac-60/S_4-14 was found promising for grain yield (10.29 t/ha) as well as medium tall for further evaluation.

In set IV, Nine modified single cross hybrids of field corn were evaluated along with two checks 900M and BARI hybrid maize 9 in RCBD with two replications at Gazipur to select high yielding desirable hybrids. Considering overall performances three hybrids (QY11/S_3-1×QY11/S_3-18)×Pac60/S_4-14, (QY11/S_3-8×QY11/S_3-30)×Utn/S_4-16 & (QY11/S_3-24×QY11/S_3-19)×Utn/S_4-8 were found promising for high grain yield (11.53-13.05 t/ha),lodging tolerance and medium tall plants (163-183cm)could be utilized for hybrid development.

In set V, Twenty eight modified single cross hybrids of field corn were evaluated inalpha lattice design with two replications at Gazipur to select desirable high yielding hybrids. Five cross combinations (7074/S_2-8×7074/S_2-5)×Utn/S_4-6, (7074/S_2-11×7074/S_2-8)×Utn/S_4-6,(7074/S_2-14×7074/S_2-6)×Pac60/S_4-21,(7074/S_2-16×7074/S_2-15)×9MG/S_4-12 &(7074/S_2-18×7074/S_2-4)×Utn/S_4-6possessed high mean yields (11.98-14.06 t/ha), lodging tolerance and earliness might be used for obtaining high yielding hybrids.

Baby corn:

In set III, Twenty three locally developed modified single cross baby corn hybrids were evaluated along with a commercial check 'Baby star' in alpha lattice design with two replications at Gazipur to select desirable quality baby corn hybrids. Five modified single cross baby corn hybrids were found promising for higher number of cobs (4 cobs/plant), little bit lower baby cob picking duration (11-13 days), green fodder yield (652-858 g/plant) and baby cobyield/plant without husk (29-33 g/plant) could be selected for further testing.

(iii) Evaluation of double cross maize hybrids at different locations

Sixteen locally developed double cross maize hybrids along with two checksPacific-60 and BARI hybrid maize 9 were evaluated at four location viz. Jessore, Khagrachari, Ishurdi and Joydebpur in RCBD with two replications to select desirable high yielding hybrids. Considering yield potentiality and stability parameters the double cross hybrids A-9 (12.3 t/ha) had highstable yield over all environments. Entry A-10 (12.1 t/ha) was also high yielder with moderate stability. The double cross hybridsA-9 (Pac60/S_3-10×Pac60/S_3-9)×(9MG/S_3-2×9MG/S_3-4) and A-10 (Pac60/S_3-10×Pac60/S_3-9)×(9MG/S_3-3×9MG/S_3-4)could be utilized for development of hybrid after verification.

(iv) Evaluation of promising maize hybrids at different agro-ecological regions of Bangladesh *(3 Sets)*

In set I, Nine locally produced promising selected maize hybrids along with three commercial check variety NK 40, 900MG and BARI hybrid maize 9were evaluated in RCBD with 3 replications at seven locations namely Gazipur, Jamalpur, Hathazari, Ishurdi, Rahmatpur, Burirhat and Jessore to assess genotype-environment interaction (GEI) and stability for selection of the best hybrid. Jamalpur, Hathazari, Ishurdi, Rahmatpur, Burirhat, and Jessore were favorable environments for maize production, whereas Gazipur was poor. Among the hybrids, commercial check 900MG showed the highest grain yield (12.50 t/ha) followed by hybrid E7 (12.22 t/ha) and E1 (11.96 t/ha)with stable performance across the locations could be used for hybrid development.

In set II, Seven locally produced promising selected hybrids along with three commercial checks, viz. BARI Hybrid Maize 9, NK40 and Pioneer 30V92 were evaluated in RCBD with 3 replications at three locations viz.Gazipur, Rahmatpur and Burirhat to assess GEI and stability for selection of the best hybrid. The environment Gazipur was poor and Barisal and Rangpur were favorable for maize production. The tested hybrid G6(12.37t/ha)and G7 (12.80 t/ha) produced higher yield withbi~1 and S^2di~0 indicated stability of the hybrids. Considering yield potentiality and stability parameter the hybrids G6 & G7 were found promising across locations could be used for hybrid development.

In set III, 8 locally produced promising selected hybrids along with three commercial checks, viz. NK-40, BARI hybrid maize 5 and BARI hybrid maize 9 were evaluated in RCBD with 3 replications at four locations viz. Gazipur, Rahmatpur, Jamalpur and Burirhat to assess GEI and stability for selection of the best hybrid. Gazipur was poor and Jamalpur, Burirhat and Rahmatpur werefavorable environments for maize production. The check BARI hybrid maize produced the highest yield (11.75 t/ha).Considering the yield potentiality and stability parameters two hybrids$P_3 \times P_7$ (11.31 t/ha) and $P_4 \times P_6$ (10.09 t/ha) were found promising and stable across the environments could be used for hybrid development.

F: Adaptive Trials

Adaptive trial with promising maize hybrids at different locationsfollowedby potato cultivation

Fifteen hybrids along with one commercial check 900M were evaluated at four locations viz.Thakurgaon, Debigonj, Rangpur and Monshigonj during Kharif 1 just after potato harvesting in RCBD with 3 replications applying with (1) and without (2) fertilizer to assess genotype environment interaction (GEI) and stability for selection of the best hybrid. The same materials were evaluated in two sets at every location following in set I fertilizers application @ 120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K. S, Zn and B, respectively and in set II, only $1/3^{rd}$ of urea the above mentioned fertilizers were applied at knee high stage of the crop. Seeds were sown on 18, 19, 20 & 24 March 2014 at Rangpur, Debigonj, Thakurgaon and Munshigonj, respectively. The environment Thakurgaon2 and Debigoaj2 were poor (without fertilizer) but Debigonj1 and Rangpur1 (with fertilizer) wasmost favorable for maize production after potato cultivation. Among the locations, Rangpur was found highly suitable

for maize cultivation in the kharif after potato cultivation. The hybrids E7 (8.28 t/ha)and E13 (8.51 t/ha) produced high yield and also showed stable across eight environments and selected and could be used for cultivation after potato harvesting. However, the experiment needs to be repeated for further conformation.

Demonstration trials of BARI maize hybridsin Rangpur, Kurigram, Nilphamari and Lalmonirhat under IAPP

Two BARI maize hybrids viz. BARI hybrid maize 7 and BARI hybrid maize 9 were demonstrated in different farmer's field at Rangpur, Kurigram, Nilphamari and Lalmonirhat districts under IAPP project to show the performance of BARI maize hybrids and recommended technologies and also to popularize the varieties to the farmers in these areas during rabi 2014-15.There were 4 types demonstrations based on land area in the above districts in which 40 demo conducted each with 40 decimal land with BHM 9; 16 demo each with 50 decimal blocks with BHM 7; and rest 8 demo each with 100 decimals large block with BHM 9. Equally the demonstrations were distributed and planted in 4 districts. Overall average grain yield of BARI hybrid maize 9 ranged from 7.3 to 9.2 t/ha in these trials. Among the four districts, the highest average grain yield (9.05 t/ha) was obtained in Rangpur. The higher average yield (8. 47 t/ha) was obtained from BARI hybrid maize 9 followed by BHM 7(8.24 t/ha), it was identical with the farmer's cultivated variety NK 40 (7.78 t/ha) and Sunshine (7.24 t/.ha). Farmer'sare interested to cultivate BARI maize hybrids, but seeds are not available at farmer level during sowing time.

G: Collaborative Program

Comparative yield trail of imported and local maize hybrids

Twenty four exotic hybrids imported by different companies, five locally produced selected experimental hybrids along with three BARI maize hybrids were evaluated in alpha lattice design with 3 replications at six locations viz. Gazipur, Rangpur, Jamalpur, Barisal, Ishurdi and Hathazari to assess genotype environment interaction (GEI) and stability for selection of the best hybrid. The environment Gazipur, Ishurdi and Jamalpur showed poorer, but Rangpur was found highly suitable for hybrid maize cultivation followed by Barisal and Hathazari. Considering the mean performance, bi and S^2di all the hybrids showed different response of adaptability under different environmental conditions. Among the hybrids IM 8119 (12.48 t/ha), Elite (11.74t/ha), IM 8013 (11.69t/ha), Titan (11.25t/ha), 9120 (11.83t/ha), VA Shaktiman (10.74 t/ha) and BHM 9 (10.78 t/ha) exhibited high and stable yield over all environments.

H: Maize Biotechnology

Modulation of oxidative damage by polyamine in maize seedlings under polyethylene glycol induced drought stress

In order to investigate the protective role of polyamines (PAs) in maize under drought stress, maize seedlings (*Zea mays* cv Khoibhutta) were imposed to 20% polyethyleneglycol (PEG)

containing 50 μM of putrescine (Put), spermidine (Spd) and spermine (Spm) for 48 hours and the contents of relative water content (RWC), proline, chlorophyll and malondialdehyde (MDA), hydrogen peroxide (H_2O_2), rate of superoxide radicals ($O_2^{\bullet-}$) generation and methyl glyoxal (MG) and the antioxidant enzyme activities of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPX), ascorbate peroxidase (APX), glutathione reductase (GR), monodehydroascorbatereductase (MDHAR), dehydroascorbatereductase (DHAR), glutathione *S*-transferase (GST), glyoxalase I (Gly-I), glyoxalase II (Gly-II) and lipoxigenase (LOX) were checked. Treatment of Put, Spd and Spm effectively maintained the balance of water content and chlorophyll contents in leaves. In addition, the data indicated that the pretreatments reduced accumulation of the proline suggesting the reduction of stress effect. They also decreased H_2O_2 content, rate of $O_2^{\bullet-}$ generation, and prevented drought induced MDA. The activities of CAT, APX and GPX were found to increase in response to put. Treatment of Put, Spd and Spm increased MDHAR activity, contrary they reduced LOX activities remarkably. Therefore, the antioxidant can be changed by PAs, which are able to modulate the radical scavenging system and to lessen in this way the oxidative stress. The results suggest that pretreatment with Put, Spd and Spm prevents oxidative damage, and the protective effect of Put was found to be greater than that of Spd and Spm.

Purification of glyoxalase-I from maize

Since Glyoxalase-I (Gly-I) is important detoxifier of methyl glyoxal (MG), this study was designed to examine the level of Gly-I in maize and to purify it from maize seedlings. Both green and non-green part of maize seedlings were used to purify. Crude proteins were precipitated by 65% $(NH_4)_2SO_4$, and dialyzed over night. The dialyzate was applied on DEAE-cellulose chromatography and eluted with linear grade of KCl from 0 to 0.2 M. In both cases, Gly-I eluted at approximately 85 mM of KCL. The active Gly-I fractions were pooled and applied on affinity chromatography (*S*-hexyl glutathione-agarose) and eluted with 1.2 mm of *S*-hexyl glutathione. The purified protein from green and non-green part had specific activity of 33.23 and 29.25 μmol min^{-1} mg^{-1}protein, respectively along with recovery of 1.47 and 162, respectively and yield of 83.11 and 68.15, respectively. In SDS-PAGE, the active purified affinity fraction was found to move with another protein. The spectrophotometric analysis showed the Gly-I protein elutes with GST protein.

I: Stress Breeding

Evaluation of inbred lines of excess sold moisture tolerant maize through line × tester method

Thirteen inbred lines were crossed with 2 testers in Line ×Testermatting design and the resulting 26 crosses along with the parents were evaluatedinalpha lattice design with two replications under excess soil moisture (ESM) condition at Jamalpur to identify ESM tolerant genotypes. Irrigation was applied at knee high stage with a ponding depth of12-15 cm continuously for 10 days. Parents with good gca for grain yield BMZ 6, BMZ 15, BMZ 66, BIL 182 & CML 116; for earliness BMZ 22 and fordwarfness BIL 26 may be used in hybridization program as donors. Better performing three crosses BMZ 22×CML 425, BMZ 66×CML 425 andKi 21×CML 425 showed considerable mean yield (4.66-5.47 t/ha)andalso had significant positive sca for yield wereselected forfurther verification.

Adaptive trials with low water required white grain hybrid maize in high barind tract

Eightselected white grained hybrid maize including two checks were evaluatedin RCBD dispersed replicationin the farmers' field of 4 villages of Godagariupazila under Rajshahi district in high barindtract during Rabi 2014-15 to test the performance of locally developed selected promising low water required white grained hybrid maize forselecting medium height best one(s) for Barind areas. In each location all the entries were cultivated in two different sets- irrigatedand non-irrigated (only single irrigation applied before flowering stage) condition. The dwarf plant and low ear heightobservedin the hybrids $Q_1 \times Q_2$ and $P_1 \times P_2$, were significantly shorter than the checks Suvra and Zimbabwe, which also showed susceptible tolodging. There was no significant yield difference in the genotypes between irrigated and non-irrigated conditions.The numerically higher yields in low-irrigated condition obtained from the hybrids$P_2 \times P_5$(7.84 & 8.45 t/ha),$P_1 \times P_2$(8.03 & 8.36 t/ha) and $P_1 \times P_4$(8.19 & 8.45 t/ha) in both irrigation regimes. At maturity stage, $P_2 \times P_5$was remained green and also showed tolerance to lodging. Considering overall performances, the hybrids $P_1 \times P_4$and $P_2 \times P_5$could be used as hybrid maize variety for barind areas. Farmers were enthusastic about white maize. They were very happy and highly interestedabout some of the hybrids performed better inlow-irrigated condition.

Selection criteria, evaluation and associated genomic regions for low-p stress tolerance in maize

Phosphorus (P) is the 2nd most important macro-element that is essential for plant growth and development. A total of 25 maize germplasm were evaluated for seedling traits in hydroponic under low phosphors (LP) (2.5×10^{-6} mol L^{-1} of KH_2PO_4) and normal phosphorus (NP) (2.5×10^{-4} mol L^{-1} of KH_2PO_4) conditions. The first two principal components (PCs) explained about 91.13% of the total variation among lines for the eight traits in maize seedling. The relative magnitudes of eigenvectors for the first principal component was 59.35%, explained mostly by total dry matter (TDM), shoot dry weight (SDW), root dry weight, maximum root length (MRL) and MSL. Genotype×traits (G×T) biplot revealed superior genotypes with combinations of favorable traits. The Euclidean genetic distance ranged from 0.61 to 29.33, indicating the high levels of variability among the inbred lines. The first three PCs explained more than 79% of total genetic variation. Some outstanding genotypes with higher value of most RNS traits were identified. These lines could be of potential use for improvement of LP tolerance in maize. Substantial genetic variation in P efficiency exists among the genotypes and a number of QTLs controlling traits for P efficiency have been identified in maize, and precision phenotyping will contribute to develop maize varieties tolerant to LP stress.

Screening of inbred lines of maize against salinity stress under field condition

The experiment composed of 85 local and CIMMYT maize inbred lines were evaluated following alpha lattice design with two replications at Banerpota, Satkhira to find out suitable salt tolerant inbred lines. Seeds were sown in Kharif season on 2nd March 2015. Variations were observed for kernel yield and other traits studied.The inbred line I-63 (3.38 t/ha) & I-5 (3.14 t/ha) performed best among the studied lines. Considering yield and other contributing traits 7maize inbred lines I-4, I-5, I-34, I-37, I-38, I-60 and I-63 were found suitable and

better under salinity stress (11 dS/m2) at field condition could be utilized for saline tolerant hybrid development.

Screening of hybrid maize against salinity stress under field condition

The experiment was conducted with 80 locally developed maize hybrids evaluated at Banerpota, Satkhira in alpha lattice design to find out suitable salt tolerant hybrids. Seeds of all the hybrids were sown in Kharif season on 1st March 2015. The variations were observed for yield other traits. The crosses H-58 (5.69 t/ha) and H-75 (4.65 t ha^{-1}) were the best among all the crosses. Considering kernel yield, yield contributing traits and overall field performances and tolerance under salinity stress (11 dS/m2) the15 hybrids viz. H-35, H-37, H-42, H-43, H-49, H-52, H-58, H-61, H-62, H-66, H-72, H-73, H-74, H-75 and H-79 were found promising and suitable and needs for further investigations in the salinity stress prone areas.

J: Nutritional Maize Development:

Study of combining ability in white grain quality protein maize

Eight white grained quality protein maize (QPM) inbred lines were mated in all possible combinations (excluding reciprocals) and the resulting 21 F_1's and along with four checks BARI hybrid maize 5, BARI hybrid maize 7, BARI hybrid maize 9 and 900M in alpha lattice design with two replications at Gazipur to select desirable best one(s).The parental lines P_4, P_7 & Q_6 were found to be the best general combiner for yield. The good combiner parents for different traits could be used in hybridization to improve yield as well as with desirable traits as donor parents for the accumulation of favorable genes. The highly significant positive SCA crosses $Q_5 \times P_7$, $P_7 \times Q_6$ & $P_7 \times Q_2$possessed high mean yield (13.79-14.53 t/ha) along with medium lodging tolerance could be utilized in variety development after verifying them in different locations.

Evaluation of quality protein maize test cross hybrids

Sixteen locally developed quality protein maize test cross hybrids were evaluated along with two checks BARI hybrid maize-5 and 900M and in alpha lattice design at Gazipur to select high yielding desirable best one(s).Considering yield, plant & ear height and overall performances two hybrids $W_1 \times W_7$ (13.06 t/ha) and$W_3 \times W_7$ (12.41 t/ha) were found promising and could be utilized in variety development after verifying them in across locations.

K:Maintenance&Seed Increase of Parent Lines, Hybrids and OPVs:

Maintenance and seed production of the parental lines of BARI maize hybrids

Purity of the parent lines is very important for a hybrid variety of maize. Total 32 kg seeds of 9parent lines (BIL-20,BIL-22, BIL-28, BIL-79, BIL-106, BIL-110, BIL-113, BIL-114 & BML-36)of different BARI maize hybridsand few other inbreds were obtained by selfing and stored for use in the next rabi season.

Total 5350 kg breeder's seed of 9 parental lines (BIL-20, BIL-22, P-1, P-7, BIL-28, BIL-79,BIL-106, BIL-110 and BIL-114)of different BARI maize hybrids were produced in different locations maintaining proper isolation during rabi 2014-15 and stored. This seed will be provided to BADC and seed companies for hybrid seed production in the next year.

Hybrid seed production of BARI hybrid maize varieties

Hybrid seed is one the prime factors for increasing area and production of maize in the country. Total 4295 kg hybrid seed of three BARI maize hybrids viz. BARI hybrid maize-5,BARI hybrid maize-7 and BARI hybrid maize-9 were produced at different stations in proper isolation condition maintaining female and male ratio of 4:2. At flowering stage, the plants from female rows were detasseled before pollen bursting and ears were collected from female plants, sorting, processed and stored for next year use and distribution.

Maintenance and seed production of BARI composite maize varieties

Total990 kg breeder's seeds of 4BARIopen-pollinated maize varieties (Barnal, Shuvra, BARI maize-7 &BARI Khoibhutta-1) were produced at different location in isolation condition maintaining female and male ratio of 2:1. At flowering male flowers (tassel) from female lines were detasseled and seeds were collected from the female plants and after sorting and processing stored them for next use.

L: CIMMYT & HTMA Program:

CIMMYT Trials:

Evaluation of CIMMYT yellow and white maize hybrids in different agro-ecological regions *(3 Sets)*

In set I, 60 CIMMYT yellow grained hybrid maize along with four commercial checks NK 40, 900MGold, 981 and BARI hybrid maize 9were evaluated in alpha lattice with 2 replications at five locations viz. Gazipur, Ishurdi, Barisal, Jessore and Jamalpur to assess genotype environment interaction (GEI) and stability for selection of the best hybrid. Gazipur, Ishurdi and Jamalpur were poor and Rahmatpur and Jessore were favorable environments for hybrid maize production. Considering the average yield potentiality and stability parameter, four hybrids E3 (12.22 t/ha), E33 (12.48 t/ha), E39(11.71 t/ha) and E60(11.41 t/ha)were found promising across locations.

In set II, Twelve CIMMYT yellow grained hybrid maize along with two local checks (BARI hybrid maize 7 and BARI hybrid maize 9) were evaluated in RCBD with three replications at two locations viz. Gazipur and Rangpur. Sowing was done on 19 and 20 June 2014 at Gazipur and Burirhat, respectively. Entry-1 (8.23 t/ha), entry-5 (8.07 t/ha)and entry-8 (7.87 t/ha) produced higher grain yield in both the locations than the check BARI hybrid maize 9 (7.46 t/ha) and need to be verified.

In set III, Thirteen CIMMYT white grained hybrid maize were evaluated along with two local checks (BARI hybrid maize-7 and BARI hybrid maize-9) in RCBD with three

replications at three locations viz. Gazipur, Jessore and Jamalpur during kharif-2 season 2014. The hybrids E-1 (7.85 t/ha),E-10(6.39 t/ha) and E-13(6.47 t/ha)showed stable yield across location and need to be further evaluated.

HTMA Trials:

Phenotyping of the test cross hybrid maize under heat stress trials at Jessore *(11sets)*

The experiment composed of 11 sets of HTMA trials and a total of 1177 test cross maize hybrids from CIMMYT, India were evaluated along with eight commercial check varieties following alpha lattice design at the RARS, Jessore during the kharif-1 season of 2014 to observe the performance of the hybrids under heat stress condition. Among the tested hybrids, considering yield and other contributing traits including heat stress tolerance the best hybrids were ZH111948 (10.72 t ha^{-1}), E25 (11.17 t/ha), E27 (10.60 t/ha), ZH132660 (10.28 t/ha), ZH132549 (10.74 t/ha), ZH132461 (10.31 t/ha), E1 (9.03 t/ha), E19 (9.63 t/ha), ZH135836 (9.41 t/ha)were selected and need to be further evaluated.

Phenotyping of the test cross hybrid maize under heat stress trials at Ishurdi *(10 Sets)*

A total of 1435 test cross maize hybrids from CIMMTY, India including eight checks were evaluated in 10 sets of trials under HTMA projectat the RARS, Ishurdi during kharif-1 season of 2014following alpha lattice design to evaluate the performance of test cross hybrids under heat stress condition. Among the tested hybridsZH1316(9.63 t/ha), ZH111656(8.19t/ha), VH101429(7.10 t/ha) and ZH138389(7.74 t/ha), E-48(6.73 t/ha),E-50(6.01t/ha),E-37(6.35 t/ha), ZH133655 (6.71 t/ha),ZH133706 (5.95 t/ha), E5 (5.95 t/ha), E75 (5.95t/ha), E4 (5.98 t/ha) produced higher yield & selected to verify them in across ecologies.

Phenotyping of the test cross hybrids under optimal temperature at Gazipur *(4 Sets)*

A total of 710 test cross maize hybrids from CIMMYT, India were evaluated under HTMA project including six commercial checks were studied at Gazipur during the kharif-1 season of 2014following alpha lattice design to test the performance of the hybrids under optimal condition. Among the tested hybrids considering yield and other characters the following hybrids ZH11379 (6.07 t/ha), ZH138384 (5.09 t/ha), ZH11316 (7.69 t/ha), ZH111948 (7.11 t/ha),E-35 (9.00 t/ha), E-37 (8.90 t/ha),E-16 (8.67 t/ha),E-132 (9.86 t/ha), E-126 (9.70 t/ha),E-81 (9.59 t/ha),E-45 (10.23 t/ha), E-135 (10.10 t/ha),E-62 (10.07 t/ha),E-47 (8.32 t/ha), ZH138151 (9.62 t/ha), ZH138207 (9.58 t/ha), ZH138204 (9.35 t/ha), E-50 (8.78 t/ha), E-44 (8.38 t/ha) and E-89 (8.30 t/ha) were selected for farther evaluation in optimal temperature across agro-ecologies.

Phenotyping of the test cross hybrids under optimal temperature at Barisal *(4 Sets)*

A total of 608CIMMYT, India developed test cross hybrids along with five checks were evaluated following alpha lattice design under HTMA project at Rahmatpur, Barisal during kharif 2014 to observe the performance of the hybrids normal temperature. Considering yield and other traits the entriesZH132497 (9.98 t/ha),ZH132454 (8.86 t/ha), ZH132450 (11.49 t/ha),ZH132650 (9.94 t/ha), ZH132745(9.91 t/ha), ZH135650 (10.54 t/ha),ZH132629(10.51

t/ha),ZH135791(10.63 t/ha), ZH135860(10.57 t/ha) and ZH135792(10.52 t/ha)were selected for further evaluation.

Demonstration trial of selected HTMA hybrids at different agro ecological condition

A total of 24selected heat tolerant CIMMYT maize hybrids and six commercial hybrids used as checks (900MG, 981, NK 40, Pioneer30V92, BHM-7 and BHM-9) were evaluated in four locations viz. Gazipur, Rahmatpur, Jessore and Burirhat to test and observe the performance of the hybrids across environments. Among the entries two yellow grained hybrid HTMA 19(12.44 t/ha) and HTMA 22(12.75 t/ha) out yielded the best check variety 981(12.41 t/ha) and were also ranked top among the tested hybrids by the participants (private seed company people, BADC and others) selected during field day at Jessore, Rahmatpur and Burirhat. HTMA 21(11.97 t/ha) a white grained hybrid also out yielded the rest five checks. Another white grained hybrid HTMA 14 (10.84 t/ha) was found moderately high yielder as well as lodging resistant. Considering overall mean grain yield and other desirable characters four hybrids viz. HTMA 14, HTMA 19, HTMA 21and HTMA 22 were found promising and hence, they could be selected for commercial cultivation across ecologies in Bangladesh.

M. Technology Transfer Activities

During 2014-15, the Plant Breeding Division of BARI arranged eleven Training Program (Conference/Refresher Course/Training- for scientists, field & office staffs, farmers) and four field days for dissemination of technologies.