Project Completion Report on
Development/validation and up-scaling of dry direct seeded boro rice system for improving crop productivity in areas with limited water supply

CGP Projects: KGF BKGET 1st Call

Project Duration: 37 Months; From 20 May 2013 to 30 June 2016

A. Basic Project Information

1. Project code & title: Development/validation and up-scaling of dry direct seeded boro rice system for improving crop productivity in areas with limited water supply;
2. KGF BKGET / Code no. CGP TF 02 – C.
3. PI / Coordinator: Prof. Dr. Md. Moshiur Rahman
   Professor, Department of Agronomy
   Bangladesh Agricultural University, Mymensingh
4. Implementing organization : Department of Agronomy
   Bangladesh Agricultural University, Mymensingh
5. Associate Organization : Department of Soil Science
   Bangladesh Agricultural University, Mymensingh
6. Project duration : 37 months; From May 2013 to June 2016
7. Geographical location of the project implementation: Godagari upazilla of Rajshahi district and Sadar upazilla of Rangpur district.
8. Land area covered (ha) : 968.42 ha
9. Total farmers involved : 32
10. Total Budget : Tk. 67, 77,500.00 and Total expenditure made: Tk. 65,83,250.00
11. Technology developed/validated/adopted as an outcome of the project: Dry direct seeded boro rice production technology has been validated and T. Aman –Mustard – Dry Direct Seeded Boro cropping pattern developed.
12. Training on (topics): Dry direct seeded boro rice production technology
    Number of persons trained : 100
    Scientists: Nil
    Scientific Assistants: Nil
    Extension personnel: Nil
    Farmers: 100 (4 batch x 25 farmers)
13. Number of farmers directly involved in the project: 32
14. Number of farmers benefitted from the project: 272

15. Publications based on the results of the project:

i. Peer reviewed journal articles (attach at least two copies each):

Three scientific articles are now under preparation for submission to different journals for publication. The titles of these articles are as follows :

(a) Productivity of dry direct seeded boro rice based cropping pattern in water short areas of Bangladesh

(b) Selection of short duration aman rice varieties for drought prone areas of Bangladesh through farmer's participatory trial.

(c) Selection of rice varieties for dry direct seeding in drought prone areas of Bangladesh through farmer's participatory trial.

ii. Reports (state the title(s) of thesis and where submitted): No.

iii. Thesis (state the title of thesis and where submitted): One Ph. D. thesis entitled "Adoption of T. aman – Mustard – dry direct seeded boro rice cropping pattern" to be submitted in the Department of Agronomy, BAU by December 2016.

iv. Popular articles (attach one copy each of the articles): One (Krishi Projukti Barta)

v. Newspaper stories (attach paper clippings): 41 (paper clippings attached)

vi. Booklets (attach one copy each): Not produced

vii. Leaflet (attach one copy each) : Not produced

viii. Others (specify and attach copy): A paper presented in the 15th Conference of Bangladesh Society of Agronomy held on 24-25 September 2016 (abstract attached).

16. Visible impact (describe in 200 words): The impact of the project activities are stated below:

(i) Farmers of the project areas became aware of the new cropping pattern (T. aman – Mustard – DDS boro) and accepted the new technology package.

(ii) A group of skilled farmers are being developed through establishment of demonstration and providing training on the new technology.

(iii) The boro rice cultivation through the new system required less than 50% irrigation water compared with the conventional puddled transplanted system which in turn reduced the fuel consumption for irrigation that ultimately contributed to reduction of green house gas emission.

(iv) The success story of the project attracted the electronic and print media personnel of the surrounding areas and the news was published in 41 different regional and national dailies and also broadcasted in different TV channels.

(v) News published in the different dailies created attention of the Ministry of Agriculture and the PI was invited through BARC to present the newly developed technology package in a seminar. Accordingly, a seminar was held at the BARC

auditorium on 9 June 2016 presided over by the Secretary, Ministry of Agriculture and the Hon'ble Minister, Ministry of Agriculture, Peoples Republic of Bangladesh was present as the Chief Guest. The Executive Vice-chairman of BARC, Director Generals of DAE, BRRI, BARI and BINA, all rice scientists of different research organizations and district level DAE officials from all over the country attended the seminar.

17. Constraints (if any)

During the implementation of the project on T. aman – Mustard – DDS boro pattern different constraints as stated below have been faced which actually limited the adoption process of that very promising technology.

(i) Scattered/sparse demonstration created a lot of problems in water management system. It was found that the crop of the demo plots were adversely affected by the unwanted flow of water from the surrounding traditional puddled transplanted plots. Establishment of a block demonstration involving all the surrounding farmers would help avoiding this problem.

(ii) Hand sowing of rice seed seems to be tedious and time consuming although it requires less labour than conventional puddled transplanting. However, mechanical seeding using VMP could alleviate the problem very easily.

(iii) The main field duration of rice in dry direct seeded system is 10-15 days longer than conventional system although the seed to seed duration in the new system is 20 days shorter. Due to longer field duration the crop matures later than the conventional system which make the crop under new system vulnerable to insect infestation and bird attack as there remains no crop in the surrounding areas. These problems will never arise if a substantial area of a certain locality is taken under the new pattern.

(iv) Weed appeared as a major problem in the initial stage of the project due to heavy infestation in dry direct seeded rice field but the problem was not so severe in the following years as the farmers became used to with the weed management techniques.

Name & Signature of PI/Coordinator

Date:

B. Executive Summary:

Boro rice shares about 56% of the total rice production (33.54 million tons) in Bangladesh and contributes a lot to the food security of the country. Traditionally boro rice is cultivated by transplanting of seedling on puddled land and continuous standing water is kept in the field for easy weed control and crop establishment. The puddle transplanted conventional irrigation (PTR-CI) system requires uplifting of huge irrigation water at the expense of enormous amount of diesel, electricity and money. Shortage of irrigation water in many parts of the country due to decline of water table as well as shrinkage of surface water sources is posing a threat to the sustainability of boro rice cultivation. Dry direct seeding (DDS) is a new approach in rice cultivation where better yield can be achieved using less than 50% irrigation water compared with the PTR-CI system. The major limitation to the adoption of this system is the poor seedling establishment especially due to low temperature during mid-December to mid-January which can be overcome by sowing the crop after mid-January. This departure in sowing time allows cultivation of a Rabi crop in between T. Aman rice and boro rice. The project was mainly aimed at studying the feasibility of adoption of the T. Aman – Rabi (mustard) – DDSR boro rice cropping system in the two water short areas (e.g. Godagari, Rajshahi and Sadar, Rangpur). Six participating farmers were selected for each location to conduct the adaptive trials. In addition, 20 farmers (associated farmers) were also selected for each demonstration (participatory farmers) to be involved in different project activities and furnishing data relating to yield and production cost of the crops grown in their own plots using their own practice. The participatory farmers cultivated T. Aman rice (variety BINA dhan7) in 0.40 ha of land and after it they raised mustard variety (BARI sharisha14) in the same field. After harvesting of mustard the whole field area was divided into two portions. Boro rice was cultivated by puddle transplanting method in 50% area of the land while the rest area was devoted to DDS method. The yield of T. Aman variety BINA dhan7 was from 4.62 to 5.35 t ha^{-1} while the yield of mustard was from 1.17 to 1.53 t ha^{-1}. In 2014, the yield of boro rice for DDSR system was 4.1 – 6.1 t ha^{-1} while in puddle transplanting system it was 5.06 to 6.20 t ha^{-1}. The lower yield was found in Rajshahi site due to spikelet sterility as a result of high temperature. In 2015, the yield of DDSR seems to be similar to that of PTR-CI. The economic analysis showed that the production cost was higher in PTR-CI while the net benefit was higher in DDSR. The present study revealed that T. Aman – Mustard – DDS boro rice is a very promising cropping pattern that could be practiced to sustain rice production with minimal water input.

C. Introduction:

Rice (*Oryza sativa*) is the staple food that contributes to about 97% of the food grains consumed in Bangladesh. Among the three growing seasons (Aus, Aman and Boro), the yield and production of rice in Boro season is the highest. For example, the contributions of Boro, Aman and Aus rice to total rice production of 33.54 million tons in 2010-11 were 55.50, 38.81 and 5.69%, respectively (AIS, 2012). The rice production had been increasing over the last four decades (during 1971-2011). The production increase was mainly contributed by increase in area and yield of boro rice (Rahman and Masood, 2012). Therefore, the food security in Bangladesh is mainly depends on boro rice production.

Boro rice is traditionally cultivated by transplanting of seedling on puddle land and continuous standing water is kept in the field for facilitating easy weed control and crop establishment. This traditional system requires huge amount of irrigation water. The irrigation water has become scarce in many parts of the country in recent years and the sustainability of boro rice production has become critical. Although alternate wetting and drying (AWD) irrigation system has been practicing by the farmers in different parts of the country, the water saving is only 20-30%. Therefore, more water efficient system for boro rice production is needed to maintain food security in the country. The cost of uplifting irrigation water has been increased due to lowering of water table. In Bangladesh, more than 80% irrigation pumps are operated by diesel which consumes about 10 million liters of diesel per day during boro season. A number of soil and environment related problems have been emerged due to lowering of water table as a consequence of uplifting the irrigation water. Under this situation, dry direct seeding method could be a vital option to sustain boro rice production with low water input. This new system can save 50-60% irrigation water (Rahman *et al*., 2012; Sudhir-Yadav *et al*., 2011). This system not only saves irrigation water but also gives higher yield and economic return than conventional system. Direct seeding is done after dry cultivation and controlled irrigation is provided to keep the land at field capacity although standing water is maintained for a very short period in this system (Sudhir-Yadav *et al*., 2011). Weed is a severe problem in this system but judicious herbicide application has been proved as an effective way to control it (Jaya Suria *et al*., 2011). Poor seedling establishment due to cold injury has been appeared as a problem to boro rice production in this system. In addition, admixture of volunteer rice plants from previous aman crop was noted in most of the farmers' field. Literature supports that rice production under dry direct seeded aerobic system reduces methane emission but it may enhance soil organic matter depletion. Inclusion of a non-rice short duration rabi crop could help overcoming these problems and helps increase system productivity and farm income with

limited irrigation. Therefore, the most suitable dry direct seeded boro rice based T.Aman-rabi-boro cropping systems needs to be developed after testing in the farmers' field to sustain boro rice production towards achieving food security in the country at the face of irrigation water shortage.

D. Specific project objective(s): (As per FRP/PIR)

(i) To adapt dry direct seeded (DDS) Boro rice and to improve system productivity of T. Aman-Mustard -DDS Boro rice with less irrigation water.
(ii) To save irrigation water and thereby to reduce cost of boro rice production.
(iii) To popularize the new production system among the farmers of the project upazilas.
(iv) To improve knowledge and skill of farmers and extension workers and to create awareness among the farmers of the project area on the improved crop production system particularly DDS Boro rice.

E. Detailed Technical Report:

a. Statement of the Researchable Problem

Dry direct seeding is an efficient way to produce boro rice with minimal water input. The yield performance under dry direct seeding system is quite satisfactory but poor seedling establishment is the major concerns towards sustainability and adoption of the technology. Sowing of boro rice at end of January or early February ensures establishment of optimum seedling population and gives satisfactory yield. However, this shifting of sowing time from mid December to mid January creates a window of cultivating different rabi crops (such as mustard or potato or cabbage) in between T. aman and Boro. The successful cultivation of these rabi crops depends on the timely sowing in last week of October which can be possible by growing short duration aman rice varieites such as Binadhan7, BRRI dhan56, BRRI dhan57 etc. Thus, the replacement of traditional long duration aman rice varieties with short duration ones, introduction of rabi crops and adoption of dry direct seeding system are the major challenges for improving productivity in the project areas. Therefore, the present on farm study was undertaken to evaluate the feasibility of introducing newly developed T. Aman-Rabi-Dry direct seeded boro rice (DDSR boro) cropping system in the water short areas for sustaining rice production with less water.

b. Research Approaches and Methodologies:

i) Approaches:

Adaptive trial on T. Aman – Rabi – Dry direct seeded (DDS) boro was undertaken in two locations viz., Godagari Upazilla of Rajshahi district and Sadar Upazilla of Rangpur district. Six participatory farmers were involved in each location (upazilla) to conduct their individual trials on 0.40 ha of land. In addition, 120 associated farmers were selected to involve them with the demonstration, training and survey activities both at Rajshahi and Rangpur sites. The participatory farmers cultivated BINA dhan7/BRRI dhan56 in transplanting method on 0.40 ha of land in Aman season after which they raised mustard (cv. BARI sharisha14) and then cultivated boro rice (cv. BRRI dhan28/BRRI dhan58) in dry direct seeded system and conventional puddle transplanted system in 2013-14. In 2015-16 more farmers were involved in the upscaling programme. The project activities were directly supervised by a field assistant in each location. The overall project activities were managed by the Research Fellow (Ph. D student) under the direct supervision of the Principal Investigator. During the harvesting period of mustard and DDSR boro rice field days were organized to popularize the new crop production systems. The results were published in the printed and electronic media towards dissemination of the technology for sustaining rice production under the water short environment of Bangladesh.

ii). Methodologies:

Site description

The experimental site in Rajshahi is located at Nagirpur, Soaigaty and Kadipur villages of Godagari upazilla. Geographically, Godagari upazilla is located at $24^{o}22^{/}$ North Latitude, $88^{o}36^{/}$ E longitude and at an elevation of 21 m and belongs to the High Barind Tract Agroecological Zone (AEZ #26). The site is a medium high land with clay loam soil. The experiment in Rangpur was established at Chandanpat Modhapara, Shahabajpur Mallirpara, Dangirpara, Panbazar Majipara and Panbazar Kodomtola villages of Rangpur Sadar upazilla. The zila lies between 25^{o} $18^{/}$ and $25^{o}57'$ north latitudes and between 88^{o} 56' and $89^{o}32'$ east longitudes. About 80% area of the district is composed of alluvial soil of Tista basin and 20% Barind land. The soil of the experimental area is loamy or silt clay loam and belongs to Tista Meander Floodpalin Agroecological Zone (AEZ#3).

Experiments conducted:

Adaptive trial of T. Aman- Rabi- Dry direct seeded boro rice cropping system conducted at two geographical regions of Bangladesh. Besides, survey of the cropping practices and farmers attitude towards new practices were conducted.

Adaptive trial of T. Aman- Rabi- Dry direct seeded boro rice cropping system

Adaptive trials for T. Aman, Rabi crop and Dry direct seeded boro rice (DDSR) were conducted during 2013 to 2016. The trial was started in 2013-14 with T. aman in both the locations involving 6 participatory farmers in each site. In Rangpur site, additional 9 and 20 farmers were involved in the up-scaling program in 2014-15 and 2015-16, respectively. All the farmers cultivated mustard cv. BARI sharisha14 after T. aman rice. In Boro season 2014-15, all the participatory farmers both in Rajshahi and Rangpur cultivated both BRRI dhan28 and BRRI dhan58 using dry direct seeding and puddle transplanting systems. In 2015-16 the upscaling programme was done only in Rangpur site where 15 farmers cultivated Binadhan7 and 11 farmers cultivated BRRI dhan56 and all 26 farmers cultivated mustard cv. BARI sharisha14. However, only 18 farmers were involved in the boro season. Yield and related parameters were recorded for each of the crops of the cropping cycle. The water requirement and cost of production of each crop was also recorded. Details of the adaptive trials for each crop during the project period have been described below.

1. Adaptive trials for T. Aman rice

Rice variety BINA dhan7 was used as test crop in aman season at 6 participatory farmer's field in both the locations in 2013 and 2014 while BINA dhan7 and BRRIdhan56 were used in 2015 only in Rangpur. The trial was established on six participatory farmer's field in 2013 and 2014 at each location while in 2015 the trial was conducted at 26 farmers' field in Rangpur District only under upscaling programme. Rice seed was collected from BADC and seedling was raised in well prepared seed bed. Aman rice seedling was transplanted in the puddled land prepared by four ploughing and cross ploughing followed by laddering. The dates of seed sowing and seedling transplanting have been presented in Tables 1, 2 and 3. The seedling was transplanted at 25 cm x 15 cm spacing allocating three seedlings per hill. During land preparation cowdung was applied @ 5 t/ha. The land was fertilized with Urea, Triple super phosphate, Muriate of potash, Gypsum and Zinc Sulphate @ 150, 110, 70, 60 and 10 kg/ha following the recommendation by BINA and BRRI. All other fertilizers except urea were applied during land preparation. Urea was applied in three equal splits at 15, 30 and 50 days after transplanting

(DAT). The crop field was infested by different weeds. Two hand weedings were done at 20 and 35 DAT. The crop was infested by stem borer and rice bug. The stem borer was controlled by applying Virtaku @ 75 g ha^{-1} during maximum tillering (MT) – panicle initiation (PI) stage (55 – 65 DAT). The stem borer was controlled by applying Virtaku @ 75 g ha^{-1} during panicle initiation (PI) stage (55 – 65 DAT). Darsban 20 EC was applied @ 3 L ha^{-1} at flowering stage to control rice bug. The crop was infested with sheath blight during PI stage which was controlled by Amister TOP 325 SC @ 600ml ha^{-1} in 2013 while Bavistin DF @ 1.5 kg ha^{-1} was used in 2014 and 2015.

Harvesting and processing

The crop was hand harvested at maturity (when 80% grains became golden yellow in colour) from 5.0 m x 2.0 m areas in three replicates from each field. The harvesting dates of crop at different farmers in both the locations during the three seasons are listed in Tables --. The harvested crop was taken to the threshing floor for threshing. The yield of grain and straw were recorded after proper drying in the sun to constant moisture content. The grain yield was adjusted to 14% moisture content.

Data Recording:

The following data were recorded:

a. Phenological data: days to panicle initiation, flowering and maturity.
b. Crop characters: plant height, number of tillers m^{-2}, number of panicles m^{-2}, length of panicle, number of filled grains $panicle^{-1}$, unfilled grains $panicle^{-1}$ and 1000-grain weight.
c. Grain and straw yield from the harvest area.

Procedure of data recording

Data on phenological parameters such as days to panicle initiation, flowering and maturity were recorded through frequent field visit. Panicle initiation was identified by the central tiller of a hill by observing five randomly selected hills for around 5-10 days during maximum tillering stage. Days to flowering was identified when 50% plants were flowered.

Plant height was measured by taking the measurement from ground level to the tip of the longest panicle. All the hills and tillers of the harvest area (5 m x 2 m) were counted to record the number of tiller and panicle m^{-2}. Panicle length was measured from the basal node of the rachis to the apex of each of the ten randomly selected panicles. Presence of any food materials in the spikelet was considered as grain. The numbers of grains in all the 10 panicles were recorded to

get the number of grain panicle^{-1}. One thousand grains were counted from each harvested area and their weight was recorded to obtained an average weight of 1000-grain.

2. Variety selection for aman rice through participatory approach

Farmers generally grow long duration rice varieties in the project area such as Guti Sharna, Suman Sharna, BR11 etc. However, short duration aman rice should be introduced instead of long duration ones to establish the T. aman – mustard – DDS boro rice cropping system. Thus, one experiment was conducted both at Rajshahi and Rangpur sites to select suitable variety among the short duration ones for accomodating into the proposed cropping pattern.

Seven transplant aman rice varieties (BINA dhan7, BRRI dhan33, BRRI dhan39, BRRI dhan49, BRRI dhan56, BRRI dhan57 and BRRI hybrid4) were cultivated in three replicates using a Randomized Complete Block Design (RCBD). The trial was established on the land of Md. Tariqul Islam and Md. Farque Hossain in Rajshahi and Rangpur sites, respectively. The unit plot size was 5m x 3 m. The distance between two replications was 75 cm and that between two plots was 50 cm.

The seed was sown on well prepared seed beds very carefully on 18 and 22 June 2013 respectively in Faruque Hossain and Tariqul Islam's land respectively. Thirty day old seedlings were transplanted on the well puddle land at 25 cm x 15 cm spacing allocating 3 seedlings hill^{-1}. During land preparation cowdung was applied @ 5 t ha^{-1}. The land was fertilized with Urea, Triple super phosphate, Muriate of potash, Gypsum and Zinc Sulphate @ 150, 110, 70, 60 and 10 kg ha^{-1}. All other fertilizers except urea were applied during land preparation. Urea was applied in three equal splits at 15, 30 and 50 days after transplanting (DAT). The crop field was infested by different weeds. Three hand weedings were done at 20, 30 and 40 (DAT). The crop was infested by stem borer and rice bug. The stem borer was controlled by applying Virtaku @ 75 g ha^{-1} during maximum tillering stage (55 -60 DAT). Darsban 20 EC was applied @ 3 L ha^{-1} at flowering stage to control rice bug. The crop was infested with sheath blight during PI stage which was controlled by Bavistin DF @ 1.5 kg ha^{-1}.

Harvesting and processing

The crop was hand harvested at maturity (when 80% grains became golden yellow in colour for all varieties while pink colour for BRRI dhan56) from central 2.0 m x 1.5 m area of each plot. The harvesting was done during 18-25 October and 20-30 October in Rangpur and Rajshahi districts, respectively (Table 1 and 2). The crop was taken to the threshing floor for threshing.

The yield of grain and straw were recorded after proper drying in the sun to constant moisture content. The grain yield was adjusted to 14% moisture content.

Data Recording:

The following data were recorded:

a. Phenological data: days to panicle initiation, flowering and maturity.
b. Crop characters: plant height, number of tillers, number of panicles, length of panicle, number of filled and unfilled grains panicle^{-1}, and 1000-grain weight.
c. Grain and straw yield from the harvest area.

Procedure of data recording

Data on phenological parameters such as days to panicle initiation, flowering and maturity were recorded through frequent field visit. Panicle initiation was identified by observing the dome like structure development in the top most node of the central tiller of a hill for around 5-10 days during maximum tillering stage. Days to flowering was identified when 50% plants flowered. Yield related attributes were recorded following the same procedure describe in the previous experiment. Data analysis was done following ANOVA technique and means were compared using DMRT.

3. Trials in Rabi seasons

i) Performance of Mustard, potato and cabbage

The suitability of cultivation of some rabi crops such as mustard, potato and cabbage needs in between T. aman and DDS boro rice to be tested for better adoption of the new T. aman – Rabi – DDS boro rice cropping pattern for its wider adoption in the project areas.

Three rabi crops (mustard, potato and cabbage) were planted after harvest of T. aman rice. The sowing or planting were done during October-November 2013. The cultural managements were undertaken as per standard practice for each crop at all the six parcipating farmers field in each location (Godagari, Rajshahi and Sadar, Rangpur). The harvesting of rabi crops were done during 20 January to 11 February 2014 in Rangpur sites while those were done during 25 January to 20 February 2014 at Rajshahi sites depending on the crop maturity. It is mentionable that the rabi crops were supposed to plant during last week of October/1st week of November 2013 but it was not possible due to high soil moisture content in the field as rainfall occurred during 14 and 15 October 2013. The yield and related attributes of each of the crops were recorded as well as the costs of production for these crops were recorded.

ii) Adaptive trial for Mustard (BARI sarisha14)

Mustard, cabbage and potato were included in the trial in 2013-14 and the performances of all the crops were satisfactory. However, due to practical reasons, mustard variety BARI shahrisha14 was only included in the trial in 2014-15 and 2015-16 cropping seasons.

Mustard was sown on well prepared land of the participatory farmers' field at Rajshahi and Rangpur sites during 20 to 30 October and 29 October to 18 November 2014, respectively. In addition, under up-scaling program the crop was sown in 15 upscaling farmer's field at Rangpur site during 30 October to 18 November 2014. In 2015, under up-scaling programme mustard was sown during 31 October to 15 November 2015 in 26 farmers field under upscaling programme. Cow dung was applied @ 5 t ha^{-1} in the field during land preparation. The land was fertilized with Urea, Triple super phosphate, Muriate of potash, Gypsum, Zinc Sulphate and Boric Acid @ 300, 180, 100, 180, 10 and 15kg ha^{-1}. All other fertilizers except urea were applied during final land preparation. Urea was applied in three equal splits at 30 % applied at the time of land preparation and 70 % at 20 and 35 days after irrigation (DAI). The crop field was infested by different weeds. Hand weedings will be done at 20 (DAS). The crop was infested with fungas during grain filling stage which was controlled by Amister TOP 325 SC @ 400ml ha^{-1}.

Harvesting and processing

BARI sharisha14 was hand harvested at maturity (when 80% grains became golden yellow in colour) from 5.0 m × 2.0 m areas in three replicates from each field. The harvesting was done during 18 - 26 October and 24 Oct. - 02 November in Rajshahi and Rangpur districts, and also harvesting of Mustard was done of Up-scaling farmers during 24 January to 12 February2015 respectively. The crop was taken to the threshing floor for threshing. The yield of grain and straw were recorded after proper drying in the sun to constant moisture content. The grain yield was adjusted to 14% moisture content.

Data Recording:

The following data were recorded following the same procedure adopted in boro season:

- **a.** Phenological data: days to flowering and maturity.
- **b.** Crop characters: plant height, number of primary branch $plant^{-1}$, number of pod $plant^{-1}$, number grains pod^{-1}, and 1000 grain weight.
- **c.** Grain and straw yield.

4. Adaptive trial for dry direct seeded boro rice

Dry direct seeding is a new system of rice cultivation which creates an opportunity of rice cultivation with about 50-60% less irrigation water compared with conventional puddled transplanted rice. Boro rice is generally sown in December and January in the conventional system but the seeds sown during this time experiences seedling mortality due to cold injury. Thus, the optimum sowing time for dry seeded boro rice is from last week of January to mid February.

The boro rice trial involved 6 participatory farmers in both locations in 2013-14 and 2014-15 cropping seasons. In 2013-14 BRRI dhan 28 was used while both BRRI dhan28 and BRRI dhan58 were used in 2014-15. In both the years, all the farmers cultivated boro rice using dry direct seeded system and puddle transplanted systems. In Rangpur site, 9 and 20 farmers were involved 2014-15 and 2015-16 under the upscaling programme who only cultivated boro rice under dry direct seeded system. It is mentionable that in 2015-16, no trial was conducted at Rajshahi while the upscaling programme was continued in Rangpur site only. Although 26 farmers cultivated T. aman and mustard, due to some unavoidable reasons, only 18 farmers cultivated boro rice under dry direct seeded system.

The rice was sown in both the locations on dry cultivated lands during 10 – 26 February 2014 at Rajsahi and 8-19 February 2014 at Rangpur sites at 25 cm x 15 cm spacing allocating four/five seeds per hill. The seed was primed by soaking in water for 30 hours followed by 30 hours incubation. The rice variety BRRI dhan28 and BRRIdhan58 was cultivated in both the locations. The crop was directly sown on dry cultivated lands during 04 – 18 February 2015 at Rajsahi and 04-10 February 2015 at Rangpur sites at 25 cm × 15 cm spacing allocating four/five seeds per hill for both the varieties. The rice variety BRRI dhan28 & BRRIdhan58 was cultivated in both the locations. The crop was directly sown on dry cultivated lands during 05– 10 February 2015 at Rajsahi and 8-19 February 2015 at Rangpur sites at 25 cm x 15 cm spacing allocating three/four seeds per hill. The crop will be harvested at maturity (when 80% grains became golden yellow in colour) from 5.0 m x 2.0 m areas in three replicates from each field. The yield of grain and straw were recorded after proper drying in the sun. The grain yield was adjusted to 14% moisture content. The crop was harvested during 11-25 June 2014 in Rajshahi and 07-11 June in Rangpur sites depending on the date of maturity. BRRI dhan28 was harvested during 05-13 June 2015 in Rajshahi and 03-06 June in Rangpur sites and BRRIdhan58 was harvested during 11-21 June 2015 in Rajshahi and 13– 15 June 2015 in Rangpur sites depending on the date of maturity. The crop was hand harvested at maturity (when 80% grains became golden

yellow in colour) from 5.0 m x 2.0 m areas in three replicates from each field. The crop was hand harvested at maturity (when 80% grains became golden yellow in colour) from 5.0 m x 2.0 m areas in three replicates from each field. The yield of grain and straw were recorded after proper drying in the sun. The grain yield was adjusted to 14% moisture content. The yield of grain and straw were recorded after proper drying in the sun. The grain yield was adjusted to 14% moisture content.

Data Recording:

The following data were recorded:

a. Phenological data: days to panicle initiation, flowering and maturity.
b. Crop characters: plant height, number of tillers m^{-2}, number of panicles m^{-2}, length of panicle, number of filled grains $panicle^{-1}$, unfilled grains $panicle^{-1}$ and 1000-grain weight.
c. Grain and straw yield (t ha^{-1}).
d. Production cost and net benefit.

Procedure of data recording

Data on phenological parameters such as days to panicle initiation, flowering and maturity were recorded through frequent field visit. Panicle initiation was identified by observing the central tiller of five randomly selected hills at around 5-10 days from maximum tillering stage. Days to flowering was identified when 50% plants flowered. Plant height was measured by taking the measurement from ground level to the tip of the longest panicle from randomly selected five hills. All the hills and tillers of 1.5 m^2 (1.5 m x 1.0 m) from the harvested area (5.0 m x 2.0 m area) were counted to record the number of tiller and panicle m^{-2}. Panicle length was measured from the basal node of the rachis to the apex of each of the ten randomly selected panicles. Presence of any food materials in the spikelet was considered as grain. The numbers of grains in all the 10 panicles were recorded to get the number of grain $panicle^{-1}$. One thousand grains were counted from each harvested area and their weight was recorded to obtain an average weight of 1000 grain.

5. Adaptive trial for dry direct seeded boro rice-2015

Rice variety BRRI dhan28 and BRRIdhan58 were cultivated in both the locations using conventional puddle transplanted (PTR-CI) system and dry direct seeded (DDSR) system. For the DDSR the crop was directly sown on dry cultivated lands during 4-18 February 2015 at Rajsahi and 04-10 February 2015 at Rangpur sites at 25 cm x 15 cm spacing allocating four/five

seeds per hill for both the varieties. In case of PTR-CI, the crop was transplanted on Puddle lands during 03 – 20 February 2015 at Rajsahi and 02 - 10 February 2015 at Rangpur sites at 25 cm x 15 cm spacing allocating two/three seedling per hill for both the varieties. The seedling age at transplanting at Rajshahi and Rangpure were 36-43 days and 36-38 days, respectively. The crop was hand harvested at maturity (when 80% grains became golden yellow in colour) from 5.0 m x 2.0 m areas in three replicates from plot of each farmer. The harvesting of variety BRRI dhan28 and BRRI dhan58 for puddle transplanted system were done during 20-25 May and 23-31 May 2015 in Rajshahi site and that was done during 22-24 May and 28-31 May in Rangpur sites, respectively. The harvesting of the dry direct seeded crop variety BRRI dhan28 and BRRI dhan58 were done during 5-13 June and 11-21 June in Rajshahi sites and those for Rangpur were 3-6 June and 13-15 June, respectively. The yield of grain and straw were recorded after proper drying in the sun. The grain yield was adjusted to 14% moisture content.

Data Recording:

The following data were recorded:

a. Phenological data: days to panicle initiation, flowering and maturity.
b. Crop characters: plant height, number of tillers m^{-2}, number of panicles m^{-2}, length of panicle, number of filled grains $panicle^{-1}$, unfilled grains $panicle^{-1}$ and 1000-grain weight.
c. Grain and straw yield (t ha^{-1}).
d. Production cost and net benefit.
e. Irrigation amount and frequency.

Procedure of data recording

Data on phenological parameters such as days to panicle initiation, flowering and maturity were recorded through frequent field visit. Panicle initiation was identified by observing the central tiller of five randomly selected hills at around 5-10 days from maximum tillering stage. Days to flowering was identified when 50% plants flowered. Plant height was measured by taking the measurement from ground level to the tip of the longest panicle from randomly selected five hills. All the hills and tillers of 1.5 m^2 (1.5 m x 1.0 m) from the harvested area (5.0 m x 2.0 m area) were counted to record the number of tiller and panicle m^{-2}. Panicle length was measured from the basal node of the rachis to the apex of each of the ten randomly selected panicles. Presence of any food materials in the spikelet was considered as grain. The numbers of grains in all the 10 panicles were recorded to get the number of grain $panicle^{-1}$. One thousand grains were

counted from each harvested area and their weight was recorded to obtain an average weight of 1000. The amount of irrigation water was measured following volumetric method. Cost of production was recorded and benefit cost ratio was calculated.

6. Variety selection trial for DDSR boro rice

Eight rice varieties such as BRRI dhan28, BRRI dhan29, Hybrid dhan Hira2, BRRI dhan hybrid3, Hybrid rice SL8, BRRI dhan50, BINA dhan14 and Pariza were sown on 8 February at Rangpur and on 24 February 2014 at Rajshahi. The variety trial was conducted at one site in each of Rajshahi and Rangpur locations using RCBD with three replications. Each of the rice varieties are grown with proper care and management following the recommended practices. Phenological data i.e. date of PI and Flowering of these varities were recorded. Plant height and tiller number were also recorded at different phenological stages of the crop. The best variety of DDSR boro was selected based on their yield performance and farmers satisfaction.

7. Economic Analysis for the T. aman – Mustard – DDS boro cropping pattern

Agronomic performances like field duration and rice equivalent yield of cropping patterns were calculated. For comparison among crop sequences, the yields of all crops were converted into rice equivalent on the basis of prevailing market prices of individual crop (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by market price of that crop divided by market price of rice. The economic indices like gross return, gross margin and marginal benefit cost ratio (MBCR) were also calculated on the basis of prevailing market price of the produces. Economic analysis involved collection of data on prices and quantities of inputs used and output produced. The inputs used included seed, fertilizer, labour, irrigation and pesticides. The outputs and inputs were valued at market prices. The MBCR of the farmer's prevalent pattern and any replacement for it can be computed as the marginal value product (MVP) over the marginal value cost (MVC). The marginal of prevalent pattern (F) and any potential replacement (E) for it was computed as (CIMMYT, 1988).

c. Results and Benefits

1. Adaptive trials in Aman season 2013

The yield of T. Aman rice cv. BINA dhan7 was quite satisfactory in both the locations (Table 3 and 4). The yield ranged between 4.06 and 5.22 t ha^{-1} in Godagari upazilla in Rajshahi while that ranged between 4.15 and 5.80 t ha^{-1} in Sadar upazilla of Rangpur. The result shows that the average yields in Rajshahi and Rangpur were 4.72 and 5.09 t ha^{-1}, respectively. The numbers of tillers and panicles $hill^{-1}$ in Rajshahi were 350 and 331 while those in Rangpur were 317 and 262, respectively. The numbers of grains $panicle^{-1}$ at Rajshahi and Rangpur were 91 and 130, respectively. The field duration in at Rajshahi and Rangpur were about 96 and 94 days, respectively. The result showed that the yield in Rangpur was higher than in Rajshahi mainly because of higher numbers of grains $panicle^{-1}$. Although number of panicle in Rajshahi was higher than Rangpur, the higher numbers of grains $panicle^{-1}$ contributed much more to the production of higher yield in Rangpur.

2. Adaptive trial Aman season 2014

The yield of T. Aman rice cv. BINA dhan7 was quite satisfactory in both the locations (Table 9 and 10). The yield ranged between 4.62 and 5.35 t ha^{-1} in Rajshahi while that ranged between 4.67 and 5.28 ha^{-1} in Rangpur. The result shows that the average yields in Rajshahi and Rangpur were 5.11 and 4.85 t ha^{-1}, respectively. The numbers of tillers and panicles $hill^{-1}$ in Rajshahi were 353 and 317 while those in Rangpur were 357 and 313, respectively. The numbers of grains $panicle^{-1}$ at Rajshahi and Rangpur were 115 and 113, respectively. The field duration in at Rajshahi and Rangpur were about 95 and 92 days, respectively. The result showed that the yield in Rajshahi was higher than that in Rangpur mainly because of higher numbers of panicle m^{-2} and grain $panicle^{-1}$. The number of panicle and grain per panicle was lower in Rangpur which may be related to the environmental factors mainly drought condition at the early growth stage and stormy weather at the flowering stage. The survey at Godagari upazilla area showed that only few farmers at cultivate short duration varieties of rice like BINA dhan7, BRRI dhan33, BRRI dhan39, BRRI dhan56, BRRI dhan57 and BRRI dhan62. Farmers mostly grow Sawrana and other late varieties which covers almost 95% of the area in aman season in this area. On the other hand, farmers at Rangpur Sadar site grows short duration varieties which covers about 20% area of land while long duration variety occupied about 80% area. Growing of mustard is not possible after long duration aman rice cultivation. However, the farmers' at Rangpur were very much interested to grow short duration T. Aman rice for early plantation of rabi crops.

3. Adaptive trial in Aman season 2015

The yield of T. Aman rice cv. BINA dhan7 and BRRIdhan56 was quite satisfactory (Table 22). The yield ranged between 4.22 to 5.14t ha^{-1} of BINA dhan7 while that ranged between 3.51 to 4.57 ha^{-1} of BRRIdhan56. The result shows that the average yields of BINA dhan7 and of BRRIdhan56 were 4.72 and 4.43 t ha^{-1}, respectively. The numbers of tillers and panicles $hill^{-1}$ in of BRRIdhan56 were 266 and 244 while those in Rangpur were 275 and 256, respectively. The numbers of grains $panicle^{-1}$ of BINA dhan7 and BRRIdhan56were 91.85and 90, respectively. The field duration in of BINA dhan7 and of BRRIdhan56 were about 95 and 88 days, respectively. The result showed that the yield of BINA dhan7 was higher than that in of of BRRIdhan56 mainly because of higher numbers of panicle m^{-2} and grain $panicle^{-1}$. The number of panicle and grain per panicle was lower in of BRRIdhan56 which may be varietal characteristic of the variety. The survey at Sader upazilla of Rangpur area showed that only 20% area of land were cultivate short duration varieties of rice like BINA dhan7, BRRI dhan33, BRRI dhan39, BRRI dhan56, BRRI dhan57 and BRRI dhan62. Farmers mostly grow Sawrana and other late varieties which covers almost 80% of the area in aman season in this area. Growing of mustard is not possible after long duration aman rice cultivation. However, the farmers at Rangpur are very much interested to grow short duration T. Aman rice for early plantation of rabi crops.

Table 1. Yield and related attributes of BINA dhan7 at farmers' field during aman season in Rajshahi in 2013

	Farmers at Godagari, Rajshahi								
Crop characters	1	2	3	4	5	6	Mean	SE	CV (%)
Plant height (cm)	99	95	109	109	96	97	100.83	5.899	6.46
No. of tillers m^{-2}	428	332	352	360	328	298	349.67	40.206	44.04
No. of panicle m^{-2}	398	312	338	339	315	285	331.17	34.96	38.30
Panicle length (cm)	24	24	25	26	24	24	24.50	0.7637	0.836
No. of filled grain $panicle^{-1}$	91	89	92	94	86	90	90.33	2.49	2.73
No. of unfilled grain $panicle^{-1}$	16	16	24	22	25	27	21.67	4.27	4.67
1000-grain weight (g)	21.75	20.75	20.95	21.98	21.50	21.85	21.46	0.46	2.14
Grain yield (t ha^{-1})	5.22	4.66	5.06	4.98	4.06	4.33	4.72	0.41	8.68
Straw yield (t ha^{-1})	6.5	5.62	5.84	5.55	5.76	5.45	5.79	0.34	6.39
Field duration (days)	94	95	95	97	97	96	95.6	1.211	1.27

Table 2. Yield and related attributes of BINA dhan7 at farmers' field during aman season in Rangpur in 2013

	Farmers at Sadar, Rangpur								
Crop characters	1	2	3	4	5	6	Mean	SE	CV (%)
Plant height (cm)	105	112	105	96	112	100	105	5.83	6.38
No. of tillers m^{-2}	280	298	280	396	318	330	317	39.81	43.61
No. of panicle m^{-2}	237	254	252	260	276	294	262.17	18.32	20.06
Panicle length (cm)	23	25	23	27	25	25	24.67	1.37	1.51
No. of filled grain $panicle^{-1}$	146	121	126	143	137	143	136	9.34	10.24
No. of unfilled grain $panicle^{-1}$	22	30	30	26	25	26	26.6	2.18	3.08
1000-grain weight (g)	21.13	21.05	20.95	20.50	21.54	21.45	21.10	0.34	0.37
Grain yield (t ha^{-1})	5.80	5.58	4.15	4.33	5.56	5.14	5.09	0.63	0.67
Straw yield (t ha^{-1})	6.82	6.70	4.98	4.73	6.20	5.95	5.89	0.79	0.87
Field duration (days)	92	93	91	97	97	95	94.17	2.562	2.72

Table 3. Yield and related attributes of BINA dhan7 at farmers' field in Rajshahi in 2014

Crop characters	1	2	3	4	5	6	Mean	SE	CV (%)
Plant height (cm)	110.53	110.03	107	110	109.3	105.5	108.73	2.01	1.85
No. of tillers m^{-2}	335.34	340.34	338.34	356	393.67	375.5	356.53	23.59	6.62
No. of panicle m^{-2}	292.34	292.34	305	339	346	345	319.95	26.14	8.17
Panicle length (cm)	24.97	25.5	24.37	26.25	24.1	24.6	24.97	0.80	3.19
No. of filled grain $panicle^{-1}$	121.84	100.3	132.37	125.27	98.47	127	117.54	14.48	12.32
No.ofunfilled grain $panicle^{-1}$	35	29.97	25.43	23.56	16.2	22.4	25.43	6.48	25.49
1000-grain weight (g)	22.94	22.79	23.05	22.16	22.6	21.82	22.56	0.48	2.12
Grain yield (t ha^{-1})	4.62	5.1	5.35	5.23	5.25	5.12	5.11	0.26	5.04
Straw yield (t ha^{-1})	5.45	5.95	6.1	5.95	6.05	5.75	5.88	0.24	4.09
Field duration (days)	93	92	93	107	91	94	95.00	5.97	6.28

Table 4. Yield and related attributes of BINA dhan7 at farmers' field in Rangpur in 2014

Crop characters	1	2	3	4	5	6	Mean	SE	CV (%)
Plant height (cm)	112	110	107	102	100	98	104.83	5.67	5.41
No. of tillers m^{-2}	360	368	410	330	384	294	357.67	40.90	11.43
No. of panicle m^{-2}	312	299	350	308	336	273	313.00	27.28	8.71
Panicle length (cm)	26	27	25	25	24	24	25.17	1.17	4.65
No. of filled grain $panicle^{-1}$	113	103	130	114	113	119	115.33	8.87	7.69
No.of unfilled grain $panicle^{-1}$	45	47	41	43	49	37	43.67	4.32	9.89
1000-grain weight (g)	21.95	22.63	23.22	22.96	22.78	22.63	22.70	0.43	1.89
Grain yield (t ha^{-1})	4.67	5.01	5.28	4.71	4.68	4.7	4.84	0.25	5.17
Straw yield (t ha^{-1})	5.5	5.75	6.15	5.56	5.25	5.5	5.62	0.31	5.44
Field duration (days)	91	90	95	94	92	92	92.33	1.86	2.02

Table 5. Plant height, number of tillers and panicle length of T.Aman rice cv. Binadhan7 at farmers' field in Rangpur in 2015

Farmers'	Plant height (cm)	Number of tiller m^{-2}	Number of effective tiller m^{-2}	Panicle length (cm)
1. Dulal	135.38	218.67	203.67	26.93
2. Alamgir	121.18	300.67	280.34	23.2
3. Subal	112.06	270.67	258.67	24.3
4. Sudatoin	131.34	228.67	209.67	23.87
5. Gopal	126.07	234.67	217.67	24.9
6. Nazrul	108.94	288.67	267.34	23.1
7. Muksedur	103.74	329.67	310.34	23.9
8. Hepzur	131.07	228.67	213.67	23.93
9. Nazrul	103.4	242.34	223.34	24.5
10. Shahider	103.8	296.67	273.67	23.43
11. Amzad	106.8	308.34	283.34	23.83
12. Azizur R	107.8	310.67	285.67	23.5
13. Gazi R.	106.54	282.34	264.67	23.67
14. Idres Ali	106.34	280.67	270.34	23.7
15. Akmal	105.1	300.34	275.34	22.77
16. Ala Uddin	105.8	296.67	271.67	22.97
Mean	113.5	276.15	256.83	23.91
SE	11.3837	34.6820	32.3757	0.98158
CV (%)	10.03	12.56	12.61	4.11

Table 6. No. of grains panicle, 1000-grain weigth and grain yield of T.Aman rice cv. Binadhan7 at farmers' field in Rangpur in 2015

Farmers'	No. of filled grain panicle^{-1}	No. of unfilled grain panicle^{-1}	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Dulal	128.6	22.56	21.75	6.07	6.68
Alamgir	88.7	17.47	21.95	5.13	5.59
Subal	91.6	32.2	21.56	5.09	5.55
Sudatoin	102.9	32.27	21.35	4.45	4.83
Gopal	99.1	32.97	21.65	4.16	4.57
Nazrul	93.1	31.5	21.75	5.14	5.61
Muksedur	84.4	28.57	22.1	4.96	5.39
Hepzur	100.5	32	21.95	4.24	4.62
Nazrul	99.6	29.7	21.35	4.45	4.84
Shahider	83.27	25.5	21.86	4.46	4.86
Amzad	79.46	30.64	21.75	4.59	5.1
Azizur R	81.74	30.17	21.72	4.59	5.05
Gazi R.	80.67	30.27	21.66	4.23	4.62
Idres Ali	81.67	28.2	21.47	4.54	4.95
Akmal	82.47	30.17	22.05	4.76	5.19
Ala Uddin	85.54	31.37	22.25	5.21	5.68
Mean	91.46	29.10	21.76	4.75	5.20
SE	12.6767	4.1023	0.2590	0.4932	0.5444
CV (%)	13.86	14.10	1.19	10.37	10.48

Table 7. Plant height, number of tillers and panicle length of T.Aman rice cv. BRRI dhan 56 at farmers' field in Rangpur in 2015

Farmers'	Plant height (cm)	Number of tiller m^{-2}	Number of effective tiller m^{-2}	Panicle length (cm)
Golzer	129	237.67	218.34	22.87
Mahbub	129.74	237.67	216.67	23.43
Rashekul	128.07	231.34	209.67	22.5
Motiar	102.94	316.34	291.34	25.2
Asraful	115.47	323.67	313.67	24.5
Golap	105.07	306.34	285.34	22.7
Obidur	128.94	239.34	224.34	23.5
Mannan	132.8	210	193.34	24.77
Anarul	109.27	325.67	275.34	24.07
Tulsi	124.67	240.34	215.67	24.1
Mean	120.60	266.84	244.37	23.76
SE	11.3167	45.1571	42.3271	0.91486
CV (%)	9.38	16.92	17.32	3.85

Table 8. No. of grains panicle, 1000-grain weigth and grain yield of T.Aman rice cv. BRRI dhan 56 at farmers' field in Rangpur in 2015

Farmers'	No. of filled grain panicle^{-1}	No. of unfilled grain panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Golzer	102.5	28.47	21.25	4.35	4.74
Mahbub	99.1	25.9	21.45	4.2	4.57
Rashekul	91.2	28.4	21.61	3.51	3.82
Motiar	76.3	30.37	22.25	4.51	4.92
Asraful	79.2	32.47	22.15	4.73	5.15
Golap	82.34	28.67	21.57	4.77	5.21
Obidur	82.76	28.54	21.85	4.5	4.98
Mannan	108.4	31.74	21.87	4.14	4.53
Anarul	86.4	24.2	21.85	4.32	4.72
Tulsi	101.4	27.7	21.56	4.26	4.64
Mean	90.96	28.646	21.741	4.329	4.728
SE	11.1962	2.4827	0.3112	0.3568	0.3954
CV (%)	12.31	8.67	1.43	8.24	8.36

Table 9. Eeconomics of T. aman rice (BINAdhan7) at farmer's field in Gudagadi, Rajshahi in 2014

Input cost	1	2	3	4	5	6
1. Land Preparation	7410	7533.5	7410	8645	7410	7904
2. Seedling transplanting	4940	5434	6916	7163	5928	8151
3. Fertilizer	11115	12350	11856	12350	10498	10498
4. Cow dung	3705	2470	3952	2470	3705	2470
5. Insecticide	1309	1235	543	1482	1729	1853
6. Fungicide/herbicide	741	692	494	1976	741	865
7. Irrigation	1976	3211	3705	3705	2470	3705
8. Intercultural operation	4940	6916	7410	6916	6916	7904
9. Harvesting and cleaning	6916	7904	7410	9880	7904	8892
10. Seed	1482	1482	1482	1482	1482	1482
11. Total cost	44534	49228	51178	56069	48783	53724
Output						
Grain yield (t ha^{-1})	4.62	5.10	5.35	5.23	5.25	5.12
Straw yield (t ha^{-1})	4.57	5.80	6.18	6.05	5.93	5.80
Total income (Tk.)	86141	94354	98677	111891	99262	97103
Net income/Loss (Tk.)	41607	45126	47499	55822	50479	43379

Seed @50Tk /kg while Rice selling @ 17.50Tk/kg,

Table 10. Eeconomics of T aman rice (BINAdhan7) cultivation at farmer`s field in Rangpur in 2014

Items	Dulal	Alamgir	Subal C. Borman	Mannan	Anarul	Tulsi
1. Land Preparation	6916	6916	6175	6422	6916	5928
2. Layout/Transplanting	5928	5928	5928	5434	5928	6916
3. C. Fertilizer	7706	7607	8318.96	10028	8175	7706
4. Cow dung	2470	3705	3705	2964	3705	2470
5. Insecticide	3211	3705	3650	2964	2470	2470
6. Fungicide	741	1482	741	1976	1482	1605
7. Irrigation	2223	2964	4199	3334	3581	3581
8. Labour(Inter.oper)	7657	6422	5681	6916	6422	7410
9. Labour (harvest and cleaning)	7657	7410	8521	7904	7410	7780
10.Seed	1976	1976	1976	1976	1976	1976
11.Total cost	46485	48115	48896	49918	48066	47843
Out put						
Grain yield (t ha^{-1})	4.67	5.01	5.28	4.71	4.68	4.70
Straw yield (t ha^{-1})	5.68	5.80	5.93	5.68	5.56	5.68
Return from grain (Tk.)						
Return from straw (Tk.)						
Total income (Tk.)	89105	95070	99783	84392	89320	89666
Net income/Loss (Tk.)	42620	46955	50887	34474	41254	41823
Selling rate of Rice@17.50Tk/kg						

Table 11. Eeconomics of T aman rice (BINAdhan7) cultivation at farmer`s in Rangpur in 2015

Items	Alamgir	Subal	Anarul	Nazrul	Muksedur	Motiar Rahman	Shahider	Asraful
1. Seed	1500.00	1500.00	1500.00	1500.00	1500.00	1500.0	1500.00	1500.00
2. Seeed bed prep.	500.00	750.00	600.00	875.00	625.00	875.00	750.00	875.00
3. Land Preparation	6525.00	6625.00	6000.00	6500.00	6250.00	6000.00	6500.00	6625.00
4. Transplanting	6000.00	6500.00	6000.00	6300.00	7500.00	7000.00	8125.00	7500.00
5. Fertilizer	7500.00	7525.00	5525.00	6500.00	5950.00	7150.00	7000.00	6500.00
6. Insecticide	2938.00	2938.00	2125.00	1775.00	2650.00	2200.00	2200.00	1400.00
7. Irrigation	2500.00	3000.00	2250.00	2250.00	2250.00	2000.00	2000.00	2250.00
8.Labour(Inter.opa.)	8000.00	6000.00	7500.00	7500.00	6000.00	5000.00	5000.00	6250.00
9.Labour(harv.&cle.)	9000.00	11000.00	10000.00	9900.00	11000.00	9500.00	10000.00	9375.00
10.Total cost	44463.00	45838.00	41500.00	43100.00	43725.00	41225.00	43075.00	42275.00
Out put								
Grain yield (t ha^{-1})	5.135	5.090	4.325	5.140	4.950	4.515	4.450	4.725
Straw yield (t ha^{-1})	5.816	5.548	4.714	5.603	5.396	4.921	4.851	5.150
Return from grain (Tk.)	77025.00	76350.00	64875.00	71960.00	74250.00	67725.00	66750.00	70875.00
Return from straw (Tk.)	8723.00	8322.00	7071.00	8404.00	8094.00	7382.00	7276.00	7725.00
Total income..(TK)	85748.00	84672.00	71946.00	80364.00	82344.00	75107.00	74026.00	78600.00
.Net income.(TK)	41285.00	38834.00	30446.00	37264.00	38619.00	33882.00	30951.00	36325.00

Table 12. Eeconomics of T aman rice (BINAdhan7) cultivation at farmer`s in Rangpur-2015

Items	Golap	Amzad	Akmal	Ala Uddin	Azizur Rahman	Gazi Rahman	Idres Ali
1. Seed	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00
2. Seeed bed prep.	625.00	875.00	750.00	625.00	750.00	750.00	750.00
3. Land Preparation	6000.00	6500.00	6000.00	6500.00	6625.00	6000.00	6000.00
4. Transplanting	8125.00	7500.00	6500.00	7500.00	7000.00	6500.00	7000.00
5. Fertilizer	6690.00	7400.00	7000.00	7900.00	6325.00	7400.00	6600.00
6. Insecticide	2200.00	1400.00	2200.00	2500.00	2175.00	1400.00	2125.00
7. Irrigation	2000.00	2000.00	3000.00	2500.00	3000.00	2000.00	2000.00
8. Labour(Inter. Opa.)	7500.00	6000.00	6500.00	6000.00	6000.00	5000.00	5750.00
9. Labour(harv.&cle.)	9375.00	10000.00	9500.00	10000.00	9000.00	9000.00	9500.00
11.Total cost	44015.00	43175.00	42950.00	45025.00	42375.00	39550.00	41225.00
Out put							
12. Grain yield (t ha^{-1})	4.775	4.595	4.768	5.217	4.593	4.225	4.535
13. Straw yield (t ha^{-1})	5.205	5.009	5.197	5.687	5.006	4.605	4.943
14. Return from grain (Tk.)	71625.00	68925.00	71520.00	78255.00	68895.00	63375.00	68025.00
15. Return from straw (Tk.)	7807.00	7513.00	7796.00	8530.00	7509.00	6908.00	7415.00
16. Total income..(TK)	79432.00	76438.00	79316.00	86785.00	76404.00	70283	75440.00
17. Net income.(TK)	35417.00	33263.00	36366.00	41760.00	34029.00	30733.00	34215.00

Table 13. Eeconomics of T aman rice (BRRIdhan56) cultivation at farmer`s in Rangpur in 2015

Items	Mannan	Tulsi	Sudatoin	Gopal	Golzer	Hepzur
1. Seed	1500.00	1500.00	1500.00	1500.00	1500.00	1500.00
2. Seeed bed prep.	500.00	750.00	750.00	750.00	750.00	750.00
3. Land Preparation	6000.00	6000.00	6000.00	6000.00	6000.00	6000.00
4. Transplanting	6000.00	6000.00	6600.00	6600.00	6500.00	6500.00
5. Fertilizer	6175.00	6088.00	6650.00	6600.00	6600.00	7250.00
6. Insecticide	2475.00	2375.00	2525.00	1775.00	4000.00	2075.00
7. Irrigation	2000.00	2250.00	3000.00	3000.00	3000.00	2000.00
8.Labour(Inter.Opa.)	8000.00	5500.00	4400.00	6000.00	6000.00	5500.00
9.Labour(harv.&cle.)	9000.00	9000.00	9900.00	9900.00	10000.00	9375.00
10.Total cost	41650.00	39463.00	41325.00	42125.00	44350.00	40950.00
Out put						
12. Grain yield (t ha^{-1})	4.140	4.263	4.455	4.160	4.350	4.240
13. Straw yield (t ha^{-1})	4.513	4.647	4.856	4.534	4.742	4.622
14. Return from grain (Tk.)	62100.00	63945.00	66825.00	62400.00	65250.00	63600.00
15. Return from straw (Tk.)	6769.00	6970.00	7284.00	6801.00	7112.00	6933.00
16. Total income..(TK)	68869.00	709150.00	74109.00	69202.00	73262.00	70533.00
17. Net income.(TK)	27219.00	314752.00	32784.00	27077.00	28012.00	29583.00

Table 14. Eeconomics of T aman rice (BRRIdhan56) cultivation at farmer`s in Rangpur in 2015

Items	Nazrul	Mahbub	Rashekul	Obidur	Dulal Hybrid
1. Seed	1500.00	1500.00	1500.00	1500.00	3300.00
2. Seeed bed prep.	875.00	1000.00	875.00	750.00	1250.00
3. Land Preparation	6000.00	6000.00	6625.00	6625.00	6500.00
4. Transplanting	7500.00	8125.00	8125.00	7500.00	6500.00
5. Fertilizer	7000.00	6600.00	6050.00	6900.00	7925.00
6. Insecticide	1275.00	1275.00	1275.00	1400.00	4913.00
7. Irrigation	2250.00	1500.00	2000.00	2000.00	2250.00
8.Labour(Inter.Opa.)	7500.00	6000.00	5000.00	6250.00	4500.00
9.Labour(harv.&cle.)	9375.00	9375.00	9000.00	9375.00	10000.00
10.Total cost	43275.00	41375.00	40450.00	42300.00	47138.00
Out put					
12. Grain yield (t ha^{-1})	4.445	4.200	3.510	4.570	6.070
13. Straw yield (t ha^{-1})	4.845	4.578	3.826	4.981	6.677
14. Return from grain (Tk.)	66675.00	63000.00	52650.00	68550.00	78910.00
15. Return from straw (Tk.)	7268.00	6867.00	5739.00	7472.00	10016.00
16. Total income..(TK)	73943.00	69867.00	58389.00	76022.00	88926.00
17. Net income.(TK)	30668.00	28492.00	17939.00	33732.00	41788.00

Table 15. Cost Benefit ratio of T.Aman rice cultivation of Up-scaling farmers' in Rangpur -2015

	Fixed cost	Variable cost	Total cost	Return ((Tk ha^{-1}) from		Gross return	Gross margin	Net return	BCR
	(Tk ha^{-1})	(Tk ha^{-1})	(Tk ha^{-1})	Grain	Straw	(Tk ha^{-1})	(Tk ha^{-1})	(Tk ha^{-1})	
	1	2	3=(1+2)	4	5	6=(4+5)	7=(6-2)	8=(6-3)	9=(6/3)
1. Dulal	44888	2250	47138	6.07(78910)	6.67(10016)	88926	86676	41788	1.887
2. Alamgir	41963	2500	44463	5.13(77025)	5.82(8723)	85748	83248	41285	1.929
3. Subal	42838	3000	45838	5.09(76350)	5.55(8322)	84672	81672	38834	1.847
4. Mannan	39650	2000	41650	4.14(62100)	4.52(67690)	68869	66869	27219	1.654
5. Anarul	39250	2250	41500	4.32(64875)	4.72(7071)	71946	69696	30446	1.734
6. Tulsi	37213	2250	39463	4.26(63945)	4.67(6970)	70915	68665	31452	1.797
7. Sudation	38325	3000	41325	4.45(66825)	4.86(7284)	74109	71109	32784	1.793
8. Gopal	39125	3000	42125	4.16(624000	4.534(6801)	69202	66202	27077	1.643
9. Nazrul	40850	2250	43100	5.14(71690)	5.61(8404)	80364	78114	37264	1.865
10. Golger	41350	3000	44350	4.35(65250)	4.75(7112)	73262	70262	28912	1.652
11. Muksedur	41475	2250	43725	4.95(74250)	5.40(8094)	82344	80094	38619	1.883
12. Hepzur	38950	2000	40950	4.24(63600)	4.62(6933)	70533	68533	29583	1.722
Motiar	3925	2000	41225	4.51(67725)	4.92(7382)	75107	73107	33882	1.822
Nazrul	41025	2250	43275	4.44(66675)	4.85(7268)	73943	71693	30668	1.709
Mahbub	39875	1500	41375	4.20(63000)	4.58(6867)	69867	68367	28492	1.689
Rashequl	37450	2000	39450	3.51(58650)	4.15((6217)	64867	62867	25417	1.644
Shahidur	41075	2000	43075	4.45(66750)	4.85(7276)	74026	72026	30951	1.719
Asraful	40025	2250	42275	4.72(70875)	5.15(7807)	78600	76350	36325	1.859
Golap	42015	2000	44015	4.77(71625)	5.21(7807)	79432	77432	35417	1.805
Obaidur	40300	2000	42300	4.57(68550)	4.981(7472)	76022	74022	33722	1.797
Amzad	41175	2000	43175	4.59(68925)	5.009(7513)	76438	74438	33263	1.770
Akmal	39950	3000	42950	4.77(71520)	5.197(7796)	79316	76316	36366	1.847
Ala Uddin	42525	2500	45025	5.22(78255)	5.687(8530)	86785	84285	41760	1.927
Azizur	39375	3000	42375	4.59(68895)	5.006(7509)	76404	73404	34029	1.803
Gazi Rah.	37550	2000	39550	4.22(63375)	4.605(6908)	70283	68283	30733	1.777
Idress Ali	39225	2000	41225	4.54(68025)	4.943(7415)	75440	73440	34215	1.929

(2) Variety selection for aman rice through participatory approach

The yield was significantly different among the varieties. The highest yield was noted in BINA dhan7 in both the locations. In Rangpur, the yield was highest (4.49 t ha^{-1}) in BINA dhan7 which was followed by BRRI dhan56 (4.11 t ha^{-1}). In Rajshahi, the highest yield (4.87 t ha^{-1}) was found in BINA dhan7 and the next highest was found in BRRI dhan49 (4.50 t ha^{-1}). The third highest yield was found with BRRI dhan39 (4.50 t ha^{-1}) in Rajshahi while the third highest in Rangpur was found with BRRI dhan33 (4.05 t ha^{-1}). The tallest plant was found with BRRI hybrid dhan4 (119 cm) in Rangpur while the tallest plant in Rajshahi was found with BRRI dhan56 (119 cm). BRRI dhan39 produced the shortest plants in Rajshahi while this variety gave the highest value (114 cm) in Rangpur site. The highest number of tillers m-2 was found at Rajshahi with BINA dhan7 (334) while that was the lowest (224) with variety BRRI dhan56. In Rangpur, the highest number of tiller was found with BRRI dhan49 (381) while the lowest was found with BRRI dhan33 (224.7). The highest filled grain was found with BRRI dhan56 (143) and the lowest with BRRI dhan33 (121) in Rangpur site. Whereas, highest number of filled grain was observed in the BRRI dybrid dhand4 (141.3) and the lowest was with BRRI dhan49 (119.70). The result showed that the yield performance of the selected rice varieties differed due to their genetic make up and actually due to agronomic management differences.

Table 16. Yield performance of seven rice varieties at farmer's field in Rangpur site

Variety	Plant height (cm)	Number of tiller m^{-2}	Number of panicle m^{-2}	Panicle length (cm)
BRRI dhan33	112.33	224.67	195.00	26.33
BRRI dhan39	114.00	285.67	247.67	26.67
BRRI dhan49	109.00	381.33	247.67	24.00
BRRI dhan56	105.67	332.33	202.33	22.67
BRRI dhan57	101.00	312.67	266.33	23.00
BRRI hybrid dhan4	119.33	237.00	218.67	25.33
BINA dhan7	109.67	266.67	243.67	25.67
Sx-	2.8872	8.7621	10.9497	0.9442
CV%	4.54	5.48	7.81	6.59
Level of signific.	*	**	**	*

Table 17. Yield performance of seven rice varieties at farmer's field in Rangpur site

Variety	Number of filled grain panicle^{-1}	Number of unfilled grain panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
BRRI dhan33	121.33	25.00	24.99	4.05	4.82
BRRI dhan39	134.00	22.00	22.09	3.71	4.59
BRRI dhan49	137.00	26.67	21.17	2.69	4.13
BRRI dhan56	143.33	17.33	23.32	4.11	4.92
BRRI dhan57	123.33	30.33	17.58	3.15	4.10
BRRI hybrid dhan4	125.33	21.33	24.02	3.76	4.79
BINA dhan7	131.67	25.33	20.99	4.49	5.15
Sx-	4.5562	1.3143	0.2182	0.1363	0.1085
CV%	6.03	9.49	1.72	6.37	4.04
Level of signific.	*	**	**	**	**

Table 18. Yield performance of seven rice varieties at farmer's field in Rajshahi site

Variety	Plant height (cm)	Number of tiller m^{-2}	Number of panicle m^{-2}	Panicle length (cm)
BRRI dhan33	108.33	230.33	176.000	26.000
BRRI dhan39	102.00	269.33	202.333	27.667
BRRI dhan49	107.00	240.33	226.667	23.667
BRRI dhan56	119.33	224.00	193.000	26.000
BRRI dhan57	111.00	312.333	270.667	23.667
BRRI hybrid dhan4	113.667	248.000	213.000	27.333
BINA dhan7	112.33	334.000	296.000	26.000
Sx-	1.0118	8.7646	12.2791	.0.3333
CV%	1.59	5.72	9.44	2.24
Level of signific.	**	**	**	**

Table 19. Yield performance of seven rice varieties at farmer's field in Rajshahi site

Variety	Number of filled grain panicle^{-1}	Number of unfilled grain panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
BRRI dhan33	136.00	26.00	25.67	3.67	4.15
BRRI dhan39	130.33	23.33	22.40	4.30	5.17
BRRI dhan49	119.67	23.33	21.67	4.50	5.37
BRRI dhan56	140.33	18.00	23.86	4.17	5.16
BRRI dhan57	133.67	21.67	17.75	3.97	4.60
BRRI hybrid dhan4	141.33	26.33	24.31	4.17	5.33
BINA dhan7	137.67	21.67	21.42	4.87	5.82
Sx-	1.8430	2.8064	0.3602	0.0557	0.1734
CV%	2.38	21.22	2.78	2.28	5.91
Level of signific.	**	ns	**	**	**

5. Trials in Rabi seasons

i) Performance of Mustard, potato and cabbage

Yield and related attributes

The crop duration, yield and cost of production of mustard, cabbage and potato varied from site to site (farmer to farmer) and also from location to location (Table 9 & 10). The crop duration for mustard, cabbage and potato at Ranpur were 90, 83 and 82 days, respectively while those for Rajshahi sites were 91, 89 and 85 days, respectively. The longer duration at Rajshahi was probably related to colder environment in this area. The yield of mustard at Rajshahi and Rangpur are 1.38 and 1.45 t ha^{-1}, respectively. The yield of cabbage was 62.3 t ha^{-1} in Rangpur while that was 42.8 t ha^{-1} in Rajshahi. In case of potato, the yield was 18.2 t ha^{-1} at Rangur and 10.4 t ha^{-1} at Rajshahi. The yields of potato and cabbage were very low compared to other farmers mainly becuase of late sowing. The sowing was late this year after T. Aman rice mainly because of unexpected rainfall during middle of October 2013. The result revealed that the yield of all these three rabi crops were higher at Rangpur than at Rajshahi. The higher yield at Ranpur was mainly related to the management practiced being adopted by the farmers themselves. The farmers at Rangpur were more motivated to the new technology than those at Rajshahi.

Table 20. Yield and related attributes of mustard at different sites in Rangpur in 2013-2014

Plant characters	1	2	3	4	5	6	Mean	Std.	CV (%)
Plant density (no. /m^2)	101	102	112	112	117	119	110.5	7.503	6.79
Plant height (cm)	100	99	89	86	91	89	92.3	5.785	6.26
Branch/plant (no.)	6.8	6	4.95	5	6	5	5.6	0.761	13.53
No. Pod/ Plant	98	110	99	87	102	101	99.5	7.449	7.48
Effective pod/plant (no.)	92	97	92	82	94	94	91.8	5.154	5.61
Noneffective pod/plant (no.)	6	13	7	5	8	7	7.6	2.804	36.58
No. Seed/pod	256	254	251	255	245	258	253.2	4.622	1.82
1000-grain wt. (g)	0.045	0.038	0.042	0.041	0.038	0.037	0.04	0.003	7.61
Grain yield (kg/ha)	1.51	1.56	1.37	1.43	1.4	1.44	1.45	0.070	4.87
Straw yield (kg/ha)	5.8	5.9	4.6	4.8	5.5	5.3	5.32	0.526	9.91
Days to flowering	32	30	31	31	32	31	31.2	0.752	2.41
Days to maturity	93	90	90	89	88	91	90.2	1.722	1.91

1, 2, 3, 4, 5 ,6 = Mannan, Anarul,Tulsi, Faruk, Alamgir, Dulal

Table 21. Yield and related attributes of mustard at different sites in Rajshahi in 2013-2014

Plant characters	1	2	3	4	5	6	Mean	Std	CV (%)
Plant density (no. /m^2)	78	103	93	71	150	111	101	28.277	27.99
Plant height (cm)	100	108	87	96	88	68	91.1	13.775	15.11
Branch/plant (no.)	7	5	4	5	5	8	5.6	1.505	26.56
Pod/ plant (no.)	120	115	68	67	79	145	99	32.242	32.56
Effective pod/plant (no.)	107	104	63	65	75	124	89.6	25.374	28.29
Noneffective pod/plant (no.)	13	11	5	2	4	21	9.3	7.118	76.26
Seed/pod (no.)	229	241	227	225	202	12	189.3	87.796	46.37
1000-grain weight (g)	0.045	0.04	0.039	0.041	0.03	0.04	0.03	0.004	12.65
Grain yield (kg/ha)	1.5	1.55	1.35	1.5	1.38	1.2	1.38	0.156	11.25
Straw yield (kg/ha)	4.2	5.7	4.9	4.3	4.6	3.2	4.48	0.828	18.46
Days to flowering	32	37	37	34	40	36	36	2.756	7.65
Days to maturity	90	92	90	88	97	91	91.3	3.076	3.36

1, 2, 3, 4, 5, 6 = Tariqul, Tofazzol, Nasir, A.Halim, A. Ahad, Zillur

Table 22. Yield and related attributes of cabbage at different sites in Rajshahi in 2013-2014

Plant characters	1	2	3	4	5	6	Mean	Std	CV (%)
Plant height	29	30	26	35	27	28	29.16	3.188	10.93
Diameter of head	12	13	9	12	10	13	11.5	1.643	14.28
%Head formation	96	95	94	95	96	93	94.83	1.169	1.23
Fresh wt head	1.9	1.8	0.9	0.85	2	1.5	1.49	0.506	33.94
Gross yield t/ha	51	48	30	29	52	47	42.83	10.496	24.50
Days to h.f	45	49	52	46	47	45	47.33	2.732	5.77
Days to maturity	88	89	87	88	90	91	88.83	1.471	1.65

Table 23. Yield and related attributes of cabbage at different sites in Rangpur in 2013-2014

Plant characters	1	2	3	4	5	6	Mean	Std.	CV (%)
Plant height	40	38	38	39	40	32	37.83	2.994	7.91
Diameter of head	18	17	15	12	13	10	14.16	3.060	21.60
%Head formation	98	95	95	94	95	92	94.83	1.940	2.04
Fresh wt head	3	2.25	2.5	2	2.5	1	2.20	0.678	30.72
Gross yield t/ha	83	63	69	56	69	34	62.33	16.488	26.45
Days to h.f	50	48	49	48	47	51	48.83	1.471	3.01
Days to maturity	83	85	85	84	80	81	83	2.097	2.52

Table 24. Yield and related attributes of potato at different sites in Rangpur in 2013-2014

	1	2	3	4	5	6	Mean	Std.	CV (%)
Plant height	95	83	88	68	66	60	76.66	13.937	18.17
No.tuber/plant	6	5	6	4	7	5	5.5	1.048	19.06
Wt.tuber/plant	183	158	131	126	177	116	148.5	28.147	18.95
No plant/m2	13	12	13	12	14	13	12.83	0.752	5.86
Gross yield t/ha	23	19	17	15	20	15	18.16	3.125	17.20
Days to germinate	12	14	13	11	13	10	12.16	1.471	12.09
Days to hervest	82	81	84	80	82	83	82	1.414	1.72

Table 25. Yield and related attributes of potato at different sites in Rajshahi 2013-2014

	1	2	3	4	5	6	Mean	Std	CV (%)
Plant height	25	20	23	62	23		30.6	17.643	15.8
No.tuber/plant	14	15	14	5	13		12.2	4.086	3.7
Wt.tuber/plant	32	29	34	105	34		46.8	32.599	29.15
No plant/m^2	28	30	29	14	29		26	6.745	6.04
Gross yield t/ha	9	8.8	9.7	14.65	10		10.43	2.409	2.16
Days to germinate	8	9	8	11	7		8.6	1.516	1.02
Days to harvest	80	87	84	90	85		85.2	3.701	3.3

In Rajshahi : 1, 2, 3, 4, 5, 6 = Tariqul, Tofazzol, Nasir, A.Halim, A. Ahad, Zillur
In Rangpur: 1, 2, 3, 4, 5, 6= Mannan, Anarul, Tulsi, Faruk, Alamgir, Dula

Cost of production and benefit

The cost of production for mustard, cabbage and potato were Tk. 4751.00-5537.00, Tk. 1570.00-1835.00, and Tk. 1354.00-1875.00 respectively at Rangpur while those values were Tk. 4252.00-5827.00, Tk. 1688.00-1939.00 and Tk. 1940.00-2490.00, respectively at Rajshahi. The gross return from mustard, cabbage and potato at Rangpur were Tk. 7980.00-9120.00, Tk. 1600.00-3200.00 and Tk. 1825.00-2484.00, respectively and those values at Rajshahi were Tk. 7360.00-9600.00, Tk. 800.00-4000.00, and Tk. 2075.00-2500.00, respectively. The net benefit out of mustard, cabbage and potato at Rangpur were Tk. 2443.00-3983.00, Tk. 30.00-1582.00 and Tk. 25.00-926.00, respectively and those values for Rajshahi were Tk. 2609.00-4493.00, Tk. 106.00-2312.00 and Tk. 10.00-420, respectively. The present study reveals that cultivation of mustard after T. aman fetches higher income for the farmers. The net benefit from cabbage and potato cultivation depends mainly on the market price at the time of harvesting. The yield obtained from mustard in both the location is quite satisfactory but the yield from cabbage and potato were not satisfactory mainly because of delay in planting time as well as farmer's reluctance to the cultivation of these crops as new intervention.

Table 26. Cost of production of mustard and economic return in Rajshai at different farmers field in 2013-2014

Input cost	1	2	3	4	5	6
1. Land Preparation	1000.00	800.00	800.00	600.00	500.00	600.00
2. Seed sowing	50.00	50.00	50.00	50.00	50.00	50.00
3. C. Fertilizer	2087.00	2127.00	2095.00	2287.00	2097.00	2127.00
4. Cow dung	700.00	800.00	700.00	-	-	-
5. Insecticide	0	175	150.00	-150.00	-	75.00
6. Fungicide	0	-	-	-	-	-
7. Irrigation	400.00	400.00	400.00	520.00	400.00	400
8. Labuor (Inter.Op)	500.00	-	-	400.00	400.00	-
9. Labuor (harvest and cleaning	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Seed	100.00	100.00	100.00	100.00	100.00	100.00
Total	5827.00	5452.00	5295.00	5107.00	4547.00	4252.00
Total Income	8740.00	9044.00	7904.00	9600.00	8480.00	7360.00
Net income/Loss	2913.00	3592.00	2609.00	4493.00	3933.00	3108.00

1, 2, 3, 4, 5, 6 =Tariqul, Tofazzol, Nasir, Halim, Ahad, Zillur

Seed @ 100Tk /kg while Grain selling @ 35-40Tk/kg

Table 27. Cost of production of mustard and economic return in Rangpur at different farmers field in 2013-2014

	1	2	3	4	5	6
1. Land Preparation	684.00	680.00	660.00	800.00	680.00	600.00
2. Seed sowing	50.00	50.00	50.00	50.00	50.00	50.00
3. C. Fertilizer	1850.00	18500.00	1900.00	650.00	1850.00	1850.00
4. Cow dung	450.00	450.00	450.00	1850.00	450.00	450.00
5. Insecticide	130.00	-	320.00	160.00	110.00	200.00
6. Fungicide	167.00	167.00	267.00	-	117.00	217.00
7. Irrigation	400.00	400.00	400.00	400.00	400.00	400.00
8. Labuor (Inter.Op)	300.00	600.00	500.00	500.00	600.00	500.00
9. Labuor (harvest and cleaning)	600.00	800.00	800.00	800.00	600.00	600.00
10.Seed	100.00	100.00	100.00	100.00	100.00	100.00
Total	4751.00	5137.00	5537.00	5310.00	4876.00	4867.00
Total income	8510.00	9120.00	7980.00	8360.00	8170.00	8436.00
Net income/Loss	3759.00	3983.00	2443.00	3050.00	3294.00	3567.00

1, 2, 3, 4, 5, 6= Mannan, Anarul, Tulsi, Faruk, Alamgir, Dulal

Seed @ 100Tk /kg while Grain selling @ 35-40Tk/kg

Table 28. Cost of production for potato and its economic return in Rajshai at different farmers field in 2013-2014

Input cost	1	2	3	4	5	6
1. Land Preparation	150.00	150.00	150.00	150	150.00	150.00
2. Layout/sowing	300.00	300.00	250.00	150	250.00	150.00
3. C. Fertilizer	360.00	350.00	360.00	370	450.00	340.00
4. Cow dung	100.00	100.00	100.00	100	-	-
5. Insecticide	-	-	-	-	-	-
6. Fungicide	150.00	140.00	150.00	150	150.00	100.00
7. Irrigation	200.00	250.00	250.00	260	150.00	200.00
8. Labour (Inter.Op)	100.00	100.00	100.00	100	100.00	100.00
9. Labour (harvest and cleaning)	200.00	200.00	200.00	200	200.00	200.00
10.Seed	600.00	600.00	700.00	600	600.00	700.00
Total cost	2160.00	2490.00	2260.00	2080	2050.00	1940.00
Total Income	2400.00	2500.00	2350.00	2500	2075.00	2090.00
Net income/Loss	240.00	10.00	90.00	420	25	150.00
	Challisa	Challisa	Challisa	Challisa	Granula	Challisa

Selling rate Granula@5Tk/kg, and Challisa @10Tk/kg

1, 2, 3, 4, 5, 6 =Tariqul, Tofazzol, Nasir, Halim, Ahad, Zillur

Seed purchase @ 20Tk/kg

Table 29. Cost of production for potato and its economic return in Rangpur at different farmers field in 2013-2014

Input cost	1	2	3	4	5	6
1. Land Preparation	108.00	110.00	120.00	150.00	110.00	110.00
2. Layout/sowing	100.00	150.00	150.00	150.00	150.00	150.00
3. C. Fertilizer	344.00	344.00	344.00	344.00	344.00	344.00
4. Cow dung	100.00	150.00	150.00	125.00	150.00	100.00
5. Insecticide	-	-	-	-	-	-
6. Fungicide	100.00	100.00	100.00	167.00	100.00	100.00
7. Irrigation	100.00	100.00	100.00	100.00	100.00	100.00
8. Labour (Inter.Op)	200.00	150.00	150.00	100.00	100.00	100.00
9. Labour (harvest and cleaning)	200.00	150.00	200.00	200.00	200.00	200.00
10.Seed	540.00	540.00	540.00	540.00	540.00	540.00
Total cost	1792.00	1354.00	1854.00	1875.00	1694.00	1644.00
Total income	2484.00	2280.00	2080.00	1900.00	2400.00	1825.00
Net income/Loss	692.00	926.00	186.00	25.00	706.00	181.00
	Granula	Granula	Granula	Granula	Granula	Granula

1, 2, 3, 4, 5, 6= Mannan, Anarul, Tulsi, Faruk, Alamgir, Dulal

Selling price @ 5 Tk/kg; Seed purchase @ 20Tk/kg

Table 30. Cost of production for cabbage and its economic return in Rajshahi at different farmers field in 2013-2014

Input cost	1	2	3	4	5	6
1. Land Preparation	150.00	150.00	150.00	150.00	150.00	150.00
2. Layout/sowing	250.00	300.00	150.00	200.00	250.00	150.00
3. C. Fertilizer	539.00	544.00	544.00	438.00	450.00	544.00
4. Cow dung	100.00	-	-	-	-	-
5. Insecticide	-	-	-	-	-	-
6. Fungicide	-	-	-	-	-	-
7. Irrigation	250.00	250.00	250.00	250.00	150.00	200.00
8. Intercultural operations	200.00	200.00	250.00	250.00	300.00	200.00
9. Harvesting and cleaning	-	-	-	-	-	-
10. Seed	450.00	450.00	450.00	400.00	500.00	500.00
Total	1939.00	1894.00	1744.00	1688.00	1800.00	1744.00
Total income	2400.00	2000.00	800.00	4000.00	2400.00	2000.00
Net income/Loss	461.00	106.00	-944.00	2312.00	600.00	256.00

1, 2, 3, 4, 5, 6 =Tariqul, Tofazzol, Nasir, Halim, Ahad, Zillur

Purchase of seedling @50Tk/100 seedling; Selling 3-5 Tk/Piece

Table 31. Cost of production for cabbage and its economic return in Rangpur at different farmers field in 2013-2014

Input cost	1	2	3	4	5	6
1. Land Preparation	108.00	110.00	120.00	150.00	110.00	110.00
2. Layout/sowing	100.00	150.00	150.00	150.00	150.00	150.00
3. C. Fertilizer	350.00	350.00	350.00	350.00	350.00	300.00
4. Cow dung	100.00	150.00	150.00	225.00	150.00	150.00
5. Insecticide	-	-	-	-	-	-
6. Fungicide	-	-	-	-	-	-
7. Irrigation	100.00	100.00	100.00	100.00	100.00	100.00
8. Labour (Inter.Op)	200.00	200.00	150.00	200.00	150.00	100.00
9. Labour (harvest and cleaning)	-	-	-	-	-	-
10.Seed	660.00	660.00	660.00	660.00	660.00	660.00
Total cost	1618.00	1660.00	1680.00	1835.00	1670.00	1570.00
Total income	3200.00	2400.00	3200.00	2400.00	3200.00	1600.00
Net income/Loss	1582.00	740.00	1520.00	565.00	1530.00	30.00

1, 2, 3, 4, 5, 6= Mannan, Anarul, Tulsi, Faruk, Alamgir, Dulal

Purchase of seedling @80Tk/100 seedling; Selling 3-5 Tk/Piece

ii) Adaptive trial for Mustard (BARI sarisha14)

The yield of BARIsarisha14 was quite satisfactory in both the locations (Table 17, 18 and 19). The yield ranged 1.17 - 1.51 t ha^{-1} in Rajshahi while that ranged 1.35 - 1.56 ha^{-1} in Rangpur and Up-scaling farmers from 1.2 – 1.52 t ha^{-1}, respectively. The result shows that the average yields in Rajshahi and Rangpur were 1.3 and 1.47 t ha^{-1}, respectively. The numbers of primary branch and pod $plant^{-1}$ in Rajshahi were 4.08 and 44.11 while those in Rangpur were 5.17 and 50.63, respectively. The numbers of seeds pod^{-1} at Rajshahi and Rangpur were 28.52 and 31.25, respectively. The field duration in at Rajshahi and Rangpur were about 88.84 and 85.84 days, respectively. The result showed that the yield in Rangpur was higher than Rajshahi that in mainly because of higher numbers of pod $plant^{-1}$ and seeds pod^{-1}. The number of pod and seeds $plant^{-1}$ was lower in Rajshahi which may be related to the environmental factors and management practices. The survey at Godagari upazilla area showed that only few farmers cultivated BARI sarisha14. Farmers mostly grow Tori-7. This variety covers almost 95% of the area. On the other hand, farmers at Rangpur Sadar Upazilla grow BARI sarisha14 which covers about 15% area of land while Tori-7 variety occupied about 85% area. Growing of mustard is not possible after long duration aman rice cultivation. However, the farmers' at Rangpur were very much interested to grow BARI sarisha14 for rabi crops.

Table 32. Yield and related attributes of BARI sharisha14 at farmers' field in Rajshahi in 2014-15

	Farmers at Godagari, Rajshahi								
Crop characters	1	2	3	4	5	6	Mean	SE	CV(%)
Plant height (cm)	81.17	88.3	94.17	89.7	97.04	95.74	91.02	2.41	6.49
No of primary branch	4.43	3.7	3.57	3.6	4.37	4.8	4.08	0.21	12.79
No. of pod plant^{-1}	33.34	43.1	41.63	53.56	40.23	52.8	44.11	1.37	7.60
No of seed pod^{-1}	26.4	28.94	30.2	27.57	27.94	30.07	28.52	0.61	5.23
1000-grain weight (g)	3.54	3.45	3. 27	3.45	3.65	3.42	3.46	0.05	3.66
Grain yield (t ha^{-1})	1.22	1.17	1.27	1.22	1.51	1.41	1.30	0.05	10.14
Straw yield (t ha^{-1})	1.61	1.58	1.85	1.77	2.18	2.06	1.84	0.10	13.07
Field duration (days)	87	87	90	88	91	90	88.83	0.70	1.94

Seed @100Tk /kg , selling of mustard @ 45Tk/kg

Table 33. Yield and related attributes of BARI sharisha14 at farmers' field in Rangpur in 2014-15

	Farmers at Sader, Ragpur								
Crop characters	1	2	3	4	5	6	Mean	SE	CV(%)
Plant height (cm)	105.43	118.67	99.1	101.9	106.6	105.37	106.18	2.74	6.33
No of primary branch	5.54	5.43	5.1	4.83	5.36	4.73	5.17	0.14	6.45
No. of pod plant^{-1}	46.07	56.34	52.4	49.83	51.73	47.43	50.63	1.51	7.32
No of seed plant^{-1}	32.47	31.6	30.57	30.7	31.2	30.97	31.25	0.29	2.24
1000-grain weight (g)	3.25	3.45	3. 27	3.45	3.45	3.42	3.25	0.71	4.67
Grain yield (t ha^{-1})	1.42	1.56	1.43	1.52	1.53	1.35	1.47	0.03	5.51
Straw yield (t ha^{-1})	2.04	2.14	1.96	2.03	2.11	1.88	2.03	0.04	4.73
Field duration (days)	85	86	85	85	86	88	85.84	0.48	1.36

Seed @100Tk /kg , selling mustard grain @ 45Tk/kg

Table 34. Eeconomics of BARI sharisha14 cultivation at farmer`s field in Gudagadi, Rajshahi in 2014-15

Input cost	1	2	3	4	5	6
1. Land Preparation	3952	3581.5	5063.5	5557.5	6175	5434
2. Seed	741	741	741	741	741	741
3.Seed sowing & others	988	1235	1111.5	1111.5	741	1111.5
4. Fertilizer	10621	9386	9262.5	9509.5	9534.2	10374
5. Cow dung	1729	3705	3334.5	3458	2470	3705
6. Insecticide	1482	1482	1482	1482	1482	1482
7. Fungicide/herbicide	1358.5	1482	1605.5	1482	2840	2593.5
8. Irrigation	1383.2	1358.5	1111.5	1383.2	1605.5	1333.8
9. Labuor (Inter.Op)	741	617.5	741	864.5	1111.5	864.5
10. Labuor (harvest and cleaning)	4940	5928	6792.5	7039.5	7780.5	5928
Total cost	27935.7	29516.5	31245.5	32628.7	34480.7	33567.3
Output						
Total production(kg)	42700	40950	44450	42700	52850	49350
Biproduct(Straw)kg	1207.5	1185	1387.5	1327.5	1635	1545
Total income	43907.5	42135	45837.5	44027.5	54485	50895
Net income/Loss	15971.8	12618.5	14592	11398.8	20004.3	17327.7

Seed@Tk.100.00/kg, selling of mustard grain @ Tk. 35.00/kg, straw @ Tk. 0.75/kg

Table 35. Eeconomics of BARI sharisha14 at farmer's field in Sadar Rangpur in 2014-15

Input cost	1	2	3	4	5	6
1. Land Preparation	3828.5	4569.5	3828.5	4075.5	3952	4075.5
2. Seed	741	741	741	741	741	741
3.Seed sowing & others	1358.5	1111.5	7.41	1111.5	1605.5	1111.5
4. Fertilizer	11238.5	12103	11856	11485.5	11362	11732.5
5. Cow dung	3705	3705	3952	3705	3705	2964
6. Insecticide	1976	1482	1729	1729	2223	1605.5
7. Fungicide/herbicid	1580.8	1580.8	1580.8	1580.8	1580.8	1580.8
8. Irrigation	1383.2	1482	988	1482	1482	1482
9. Labuor (Inter.Op)	1111.5	1235	1111.5	1482	1111.5	1111.5
10. Labuor (harvest and cleaning)	7533.5	7904	7657	7039.5	6916	6792.5
Total cost	34457	35914	33451	34432	34679	33197
Output						
Total production(kg)	49700	54600	50050	53200	53550	47250
Total production (Straw)kg	1530	1605	1470	1522.5	1582.5	1410
Total income	51230	56205	51520	54722.5	55132.5	48660
Net income/Loss	16773	20291	18069	20291	20454	15463

Seed@Tk.100.00/kg, grain @ Tk. 35.00/kg, straw @ Tk. 0.75/kg

Table 36. Eeconomics of BARI sharisha14 at farmer's field in Rangpur in 2015-2016

Input cost	Dulal	Alamgir	Subal	Mannan	Anarul	Tulsi
1. Seed	375.00	375.00	375.00	375.00	375.00	375.00
1. Land Preparation	6250.00	4500.00	6125.00	6250.00	6250.00	6000.00
3.Seed sowin&ohers	800.00	800.00	900.00	750.00	1050.00	750.00
4. Fertilizer	12950.00	12875.00	10800.00	10250.00	11700.00	10650.00
6. Pesticide	2315.00	2663.00	2313.00	1388.00	1388.00	1887.00
8. Irrigation	1000.00	1000.00	1000.00	1250.00	1000.00	1250.00
9. Labor (Inter.Op)	5000.00	4500.00	4500.00	5000.00	4000.00	4500.00
10. Labor (ha. & cl.)	7500.00	7000.00	7500.00	7000.00	7000.00	7250.00
Total cost	34940.00	33713.00	33513.00	32263.00	32763.00	32662.00
Output						
Seed Yield(tha^{-1})	1.54	1.49	1.56	1.51	1.54	1.50
Return from sharisha.TK.	53900.00	52150.00	54600.00	52850.00	53900.00	52500.00
Stover yield.(tha^{-1})	1.97	2.11	2.16	2.01	2.13	2.13
Return from stover,Tk.	1478.00	1585.00	1619.00	1508.00	1599.00	1596.00
Total income.(TK)	55378.00	53735.00	56219.00	54358.00	55499.00	54096.00
Net income/Loss.(TK)	20438.00	20022.00	22708.00	22095.00	22736.00	21434.00

Seed @75Tk /kg, mustard grain @ 35.00Tk/kg and stover @ 0.75 Tk/kg.

Table 37. Eeconomics of BARI sharisha14 at farmer's field in Rangpur in 2015-2016

Input cost	Gopal	Golger	Nurul	Gazi.Rah.	Mahbubul.	Azizar R.
1. Seed	375.00	375.00	375.00	375.00	375.00	375.00
1. Land Preparation	5000.00	5000.00	6125.00	6250.00	6000.00	6250.00
3.Seed sowin&ohers	1000.00	900.00	900.00	750.00	800.00	750.00
4. Fertilizer	9525.00	11150.00	8250.00	11750.00	11700.00	11650.00
6. Pesticide	1388.00	1413.00	1413.00	1863.00	1863.00	1887.00
8. Irrigation	1250.00	1000.00	1000.00	1125.00	1000.00	1250.00
9. Labor (Inter.Op)	5500.00	4500.00	5000.00	4000.00	4000.00	4000.00
10. Labor (ha. & cl.)	7500.00	8000.00	8500.00	7000.00	7500.00	7000.00
Total cost	31538.00	32338.00	31563.00	32638.00	32238.00	33162.00
Output						
Seed Yield(tha^{-1})	1.46	1.40	1.49	1.46	1.50	155
Return from sharisha.TK.	51100.00	49000.00	52150.00	52100.00	52500.00	54250.00
Stover yield.(tha^{-1})	2.11	2.13	2.07	2.19	2.10	2.09
Return from stover,Tk.	1580.00	1598.00	1553.00	1643.00	1575	1568.00
Total income.(TK)	52680.00	50598.00	53703.00	53743.00	54075.00	55818.00
Net income/Loss.(TK)	21142.00	18260.00	22140.00	21105.00	21837.00	22656.00

Seed @75Tk /kg, mustard grain @ 35.00Tk/kg and stover @ 0.75 Tk/kg

Table 38. Eeconomics of BARI sharisha14 at farmer's field in Rangpur in 2015-2016

Input cost	Ripon C.	Shudation	Rashequl	AlaUddin	Obidul	Muksedul
1. Seed	375.00	375.00	375.00	375.00	375.00	375.00
1. Land Preparation	5000.00	5000.00	55000.00	5000.00	5500.00	5000.00
3.Seed sowin&ohers	600.00	800.00	700.00	550.00	800.00	750.00
4. Fertilizer	11200.00	10525.00	11525.00	10750.00	10700.00	10650.00
6. Pesticide	1462.00	1863.00	1863.00	1463.00	1863.00	1464.00
8. Irrigation	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
9. Labor (Inter.Op)	4500.00	4000.00	4000.00	4000.00	4000.00	4000.00
10. Labor (ha. & cl.)	7500.00	7000.00	6500.00	6500.00	7000.00	7500.00
Total cost	31637.00	30563.00	31463.00	29638.00	31238.00	30739.00
Output						
Seed Yield(tha^{-1})	1.46	1.47	1.55	1.48	1.51	1.47
Return from sharisha.TK.	51100.00	51450.00	54250.00	51625.00	52850.00	51450.00
Stover yield.(tha^{-1})	2.22	2.04	2.06	2.18	2.23	2.00
Return from stover,Tk.	1650.00	1530	1545	1635.00	1673.00	1500.00
Total income.(TK)	52750.00	52980.00	55795.00	53260.00	54523.00	52950.00
Net income/Loss.(TK)	21113.00	22417.00	24332.00	23622.00	23285.00	22211.00

Seed @75Tk /kg, grain @ 35.00Tk/kg and stover @ 0.75 Tk/kg.

Table 39. Eeconomics of BARI sharisha14 at farmer's field in Rangpur in 2015-2016

Input cost	Hapzur	Nazrul	Shahidur	Habibullah
1. Seed	375.00	375.00	375.00	375.00
1. Land Preparation	5500.00	5000.00	5500.00	5000.00
3.Seed sowin&ohers	600.00	700.00	600.00	700.00
4. Fertilizer	9525.00	10150.00	10250.00	10750.00
6. Pesticide	1300.00	1413.00	1413.00	1863.00
8. Irrigation	1000.00	1000.00	1000.00	1000.00
9. Labor (Inter.Op)	4500.00	4000.00	4000.00	4000.00
10. Labor (ha. & cl.)	7500.00	8000.00	7500.00	7000.00
Total cost	30300.00	30638.00	30738.00	30688.00
Output				
Seed Yield(tha^{-1})	1.45	1.49	1.5	1.51
Return from sharisha.TK.	50750.00	52150.00	52500.00	52850.00
Stover yield.(tha^{-1})	2.01	2.08	1.98	2.11
Return from stover,Tk.	1508.00	1560.00	1485.00	1583.00
Total income.(TK)	52258.00	53710.00	53985.00	54433.00
Net income/Loss.(TK)	21870.00	23072.00S	23247.00	23745.00

Seed @75Tk /kg, grain @ 35.00Tk/kg and stover @ 0.75 Tk/kg.

6. Adaptive trial for dry direct seeded rice in boro season

The yield of boro rice cv. BRRI dhan28 under dry direct seeded system was quite satisfactory in both the locations. The average yield in Rajshahi and Rangpur were 4.83 (range 4.1- 6.1) t ha^{-1} in Rajshahi and 5.32 (range 4.94- 6.15) t ha^{-1} in Rangpur sites. The numbers of tillers and panicles m^{-2} in Rajshahi were 410 and 363 while those in Rangpur were 464 and 404, respectively. The numbers of grains $panicle^{-1}$ at Rajshahi and Rangpur were 111 and 128, respectively. The number of unfilled spikeletpanicle^{-1} in Rajshahi and Rangpur were 36 and 33, respectively. The field duration (from sowing to harvesting) of the crop was 114 to 123 days in Rajshahi and 112 to 121 days in Rangpur.The main reason of lower yield at Rajshahi was related to the lower number of grains per panicle and higher number of unfertile spikelet. The number of effective tiller was also lower in Rajshahi than Rangpur site (363 vs 404). The average yield of the farmers practice was 5.3 and 5.5 t ha^{-1} respectively, in Rajshahi and Rangpur sites. The net return from DDSR crop was Tk. 5350-10325/- at Rajshahi while that was Tk. 8190-13360/- at Rangpur. The net return for puddle transplanted rice was 9087-10288 at Rajshahi and Tk. 9495-12670/- at Rangpur. The number of irrigation given to the puddle transplanted rice was 20-22 at Rajshahi and 20-29 at Rangpur while that was 8-10 and 7-11 in Rajshahi and Rangpur, respectively. Thus the irrigation water saving was higher in Rangpur than Rajshahi.

The yield of boro rice cv. BRRI dhan28 under dry direct seeded system was quite satisfactory in both the locations. The average yield in Rajshahi and Rangpur were 5.50 (range 5.23 – 6.13) t

ha^{-1} in Rajshahi and 5.45 (range 5.11 - 6.03) t ha^{-1} in Rangpur sites. The numbers of tillers and panicles m^{-2} in Rajshahi were 410 and 363 while those in Rangpur were 464 and 404, respectively. The numbers of grains $panicle^{-1}$ at Rajshahi and Rangpur were 91 and 86, respectively. The number of unfilled spikelet in Rajshahi and Rangpur were 30 and 33, respectively. The field duration (from sowing to harvesting) of the crop was 114 to 123 days in Rajshahi and 112 to 121 days in Rangpur.The main reason of lower yield at Rajshahi was related to the lower number of grains per panicle and higher number of unfertile spikelet. The number of effective tiller was also lower in Rajshahi than Rangpur site (363 vs 404). The average yield of the farmers practice was 5.3 and 5.5 t ha^{-1} respectively, in Rajshahi and Rangpur sites. The net return from DDSR crop was Tk. 5350-10325/- at Rajshahi while that was Tk. 8190-13360/- at Rangpur. The net return for puddle transplanted rice was 9087-10288 at Rajshahi and Tk. 9495-12670/- at Rangpur. The number of irrigation given to the puddle transplanted rice was 20-22 at Rajshahi and 20-29 at Rangpur while that was 8-10 and 7-11 in Rajshahi and Rangpur, respectively. Thus the irrigation water saving was higher in Rangpur than in Rajshahi.

Table 40. Yield and related attributes of DDSR boro rice BRRI dhan 28 at farmers' field in Rajshahi 2014

Crop characters	1*	2	3	4	5	6	Mean	SE	CV (%)
Plant height (cm)	107	104	93	102	103	99	101.33	4.84	4.78
No. of tillers m^{-2}	441	420	396	405	385	410	409.50	19.52	4.77
No. of panicle m^{-2}	396	387	310	362	351	371	362.83	30.60	8.43
Panicle length (cm)	25	25	22	23	22	22	23.17	1.47	6.35
No.of grain $panicle^{-1}$	138	117	100	105	103	105	111.33	14.29	12.84
No. of unfilled spikelets $panicle^{-1}$	21	35	42	40	41	39	36.33	7.89	21.72
1000-grain weight (g)	21.25	20.95	21.5	21.3	21.5	21.25	21.29	0.20	0.96
Grain yield (t ha^{-1})	6.1	5.2	4.1	4.5	4.5	4.6	4.83	0.71	14.79
Straw yield (t ha^{-1})	6.65	6.05	5.24	5.05	5.3	5.55	5.64	0.60	10.70
Field duration (days)	114	121	116	122	123	115	118.50	3.94	3.32

*** The crop characters presented for BRRI dhan58 in this column**

Name of participatory farmers:

1. Insun	2. Mynul	3. Rintu	4. Saidur	5. Monir	6. Toriqul

Table 41. Yield and related attributes of DDSR boro rice BRRI dhan 28 at farmers' field in Rangpur-2014

Crop characters	1	2	3	4	5	6	Mean	SE	CV (%)
Plant height (cm)	103	100	95	100	98	96	98.67	2.94	2.98
No. of tillers m^{-2}	456	500	480	432	480	437	464.17	26.93	5.80
No. of panicle m^{-2}	408	425	408	384	432	391	408.00	18.60	4.56
Panicle length (cm)	26	24	22	24	24	24	24.00	1.26	5.27
No. of grain $panicle^{-1}$	138	125	123	129	126	129	128.33	5.28	4.11
No. of unfilled spikelets $panicle^{-1}$	27	38	36	32	35	31	33.17	3.97	11.97
1000-grain weight (g)	21.5	21.9	21.5	21.3	21.5	21.25	21.49	0.23	1.07
Grain yield (t ha^{-1})	6.15	5.03	5.05	4.98	5.74	4.94	5.32	0.51	9.53
Straw yield (t ha^{-1})	6.65	5.85	6.15	5.95	6.5	5.75	6.14	0.36	5.92
Field duration (days)	112	113	114	121	120	118	116.33	3.83	3.29

Name of participatory farmers:

1. Dulal	2. Alamgir	3. Subal	4. Mannan	5. Anarul	6. Tulsi

Table 42. Yield and related attributes of DDSR boro rice cv. BRRI dhan 28 under DDSR at farmers' field in Rajshahi-2015

	Participatory Farmers at Rajshahi site								
Crop characters	1	2	3	4	5	6	Mean	SE (±)	CV (%)
Plant height (cm)	101.73	100.10	101.27	100.87	102.63	101.57	101.36	0.32	0.77
No. of tillers m^{-2}	399.34	380.34	390.34	399.67	379.67	410.67	393.34	4.54	2.83
No. of panicle m^{-2}	340.34	332.67	347.67	338.34	328.67	363.34	341.84	4.62	3.31
Panicle length (cm)	23.37	23.20	23.17	22.87	23.17	23.70	23.25	0.10	1.08
No. of grain $panicle^{-1}$	91.23	89.30	89.73	90.40	89.93	95.27	90.98	0.82	2.21
No. of unfilled spikelets $panicle^{-1}$	28.77	29.20	31.43	30.63	31.83	24.87	29.46	0.95	7.90
Grain weight (g)	21.87	21.66	21.45	21.75	21.44	21.95	21.699	0.88	0.89
Grain yield (t ha^{-1})	5.44	5.33	5.60	5.25	5.23	6.13	5.50	0.13	5.63
Straw yield (t ha^{-1})	5.82	5.7	5.99	5.62	5.60	6.56	5.88	0.14	5.63
Field duration (days)	116	117	120	122	121	115	118.50	1.07	2.22

Name of participatory farmers:

2. Insun	2. Mynul	3. Rintu	4. Saidur	5. Monir	6. Toriqul

Table 43. Yield and related attributes of rice cv. BRRI dhan 28 under DDSR at farmers' field in Rangpur-2015

	Participatory Farmers at Rangpur site								
Crop characters	1	2	3	4	5	6	Mean	SE (±)	CV (%)
Plant height (cm)	101.87	103.00	101.60	103.47	103.30	104.43	102.95	0.39	0.94
No. of tillers m^{-2}	441.67	418.67	418.34	404.67	422.67	399.34	417.56	5.55	3.25
No. of panicle m^{-2}	342.67	361.67	350.34	343.34	361.34	350.34	351.62	3.11	2.16
Panicle length (cm)	23.97	23.17	23.30	23.43	23.67	23.27	23.47	0.11	1.17
No. of grain $panicle^{-1}$	94.83	80.17	82.23.	89.97	81.10	84.63	86.14	2.26	6.43
No. of unfilled spikelet $panicle^{-1}$	29.10	34.73	37.30	30.27	27.10	36.47	32.50	1.58	11.88
1000-grain weight (g)	21.78	21.25	21.55	21.67	21.95	21.35	21.59	0.10	1.11
Grain yield (t ha^{-1})	6.03	5.5	5.25	5.11	5.68	5.15	5.45	0.12	6.55
Straw yield (t ha^{-1})	6.46	5.92	5.75	5.97	6.19	5.67	5.98	0.14	5.59
Field duration (days)	116	120	117	120	121	118	118.67	0.73	1.51

Name of participatory farmers:

1. Dulal	2. Alamgir	3. Subal	4. Mannan	5. Anarul	6. Tulsi

Table 44. Yield and related attributes of DDSR boro rice cv. BRRI dhan 58 at farmers' field in Rajshahi-2015

	Participatory Farmers at Rajshahi site								
Crop characters	1	2	3	4	5	6	Mean	SE (±)	CV (%)
Plant height (cm)	106.35	105.50	106.67	104.67	105.67	102.67	105.26	0.54	1.25
No. of tillers m^{-2}	409.67	398.34	401.67	397.67	398.34	403.34	401.51	1.71	1.04
No. of panicle m^{-2}	353.67	345.34	358.34	349.67	341.34	375.34	353.95	4.50	3.11
Panicle length (cm)	24.37	23.27	23.87	23.57	24.21	24.17	23.91	0.16	1.62
No. of grain $panicle^{-1}$	91.23	89.30	89.73	90.40	89.93	95.27	90.98	0.82	2.21
No. of unfilled spikelets $panicle^{-1}$	28.77	29.20	31.43	30.63	31.83	24.87	29.46	0.95	7.90
1000-grain weight (g)	21.75	21.84	21.67	21.93	21.54	22.00	21.79	0.06	0.71
Grain yield (t ha^{-1})	5.69	5.54	5.79	5.49	5.44	6.28	5.71	0.12	4.97
Straw yield (t ha^{-1})	6.20	6.04	6.32	5.98	5.93	6.85	6.22	0.13	5.00
Field duration (days)	123	124	126	128	128	123	125.33	0.87	1.70

Name of participatory farmers:

1. Insun	2. Mynul	3. Rintu	4. Saidur	5. Monir	6. Toriqul

Table 45. Yield and related attributes of DDSR boro rice cv. BRRI dhan 58 at farmers' field in Rangpur-2015

	Participatory Farmers at Rangpur								
Crop characters	1	2	3	4	5	6	Mean	SE (±)	CV (%)
Plant height (cm)	102.66	105.60	103.80	105.77	108.60	106.43	105.48	0.77	1.80
No. of tillers m^{-2}	421.67	410.45	408.34	398.76	413.87	389.67	407.13	4.23	2.55
No. of panicle m^{-2}	316.87	323.67	336.34	323.67	354.67	334.67	331.65	5.02	3.71
Panicle length (cm)	24.97	24.17	22.30	24.43	23.34	24.34	23.93	0.36	3.64
No. of grain $panicle^{-1}$	85.50	83.26	85.65.	87.80	86.10	87.74	86.08	0.68	1.94
No. of unfilled spikelets $panicle^{-1}$	25.10	31.73	32.25	32.27	25.10	31.56	29.67	1.32	10.92
1000-grain weight (g)	22.1	21.75	21.87	21.95	22.05	22.85	22.10	0.15	1.61
Grain yield (t ha^{-1})	6.23	5.75	5.55	5.36	5.84	5.45	5.70	0.12	5.09
Straw yield (t ha^{-1})	6.85	6.32	6.11	5.89	6.42	5.99	6.26	0.13	5.09
Field duration (days)	122	127	124	126	127	125	125.17	0.72	1.42

Name of participatory farmers:

1. Dulal	2. Alamgir	3. Subal	4. Mannan	5. Anarul	6. Tulsi

Table 46. Eeconomics of DDSR boro rice at farmers' field in Gudagadi, Rajshahi-2014

Input cost	Ahad	Tariqul	Nasir	Tofazzol	Zillur	Nur Hossain
1. Land Preparation	600.00	500.00	600.00	700.00	800.00	500.00
2. Layout/sowing	1100.00	1100.00	1000.00	800.00	1100.00	1050.00
3. C. Fertilizer	2375.00	2375.00	2375.00	2375.00	2375.00	2375.00
4. Cow dung	-	-	-	-	-	-
5. Insecticide	1900.00	1280.00	1100.00	1600.00	2200.00	1800.00
6. Fungicide	900.00	500.00	300.00	700.00	800.00	900.00
7. Irrigation	1400.00	1350.00	900.00	1450.00	1250.00	1400.00
8. Labor(inter.operation)	2000.00	1800.00	1000.00	1500.00	1800.00	1500.00
9. Labour (harvest & Proc	1450.00	1150.00	900.00	1100.00	1300.00	1300.00
10.Seed	800.00	800.00	800.00	800.00	800.00	800.00
Total cost	12525.00	11055.00	8975.00	11025.00	12400.00	11625.00
Output						
Product kg	1220(6.1)	1040(5.2)	820(4.1)	900(4.5)	900(4.5)	920(4.6)
Bi-product kg	1330	1210	1048	1010	1060	1110
Total Income	22680.00	19400.00	15398.00	17750.00	17650.00	20425.00
Net income/Loss	10155.00	8355.00	6423.00	6725.00	5350.00	8800.00

Note: Data presented for 50 decimal land, rice selling rate 17.50Tk/kg.

Table 47. Eeconomics of puddle transplanted boro rice at farmers' field in Gudagadi, Rajshahi-2014

Input cost	Ahad	Tariqul	Nasir	Tofazzol	Zillur	Nur Hossain
1. Land Preparation	1500.00	1100.00	1350.00	1300.00	1100.00	1000.00
2. Layout/sowing	1500.00	1200.00	1250.00	1400.00	1200.00	1200.00
3. C. Fertilizer	2200.00	1900.00	1750.00	2000.00	2000.00	1900.00
4. Cow dung	-	-	-	-	-	-
5. Insecticide/Herbicide	800.00	500.00	700.00	600.00	600.00	800.00
6. Fungicide	200.00	200.00	300.00	300.00	280.00	400.00
7. Irrigation	2400	2700.00	2500.00	3000.00	2700.00	2800.00
8. Labourer (intercultural operation)	2000.00	2000.00	1900.00	1800.00	2500.00	2000.00
9. Labour (harvest and cleaning)	1300.00	1400.00	1100.00	1400.00	1300.00	1300.00
10.Seed	400.00	400.00	400.00	400.00	400.00	400.00
11.Total cost	11900.00	11400.00	10850.00	11400.00	12080.00	11800.00
Output						
Grain yield (t ha-1)	5.31	5.56	5.06	5.56	5.43	5.19
Straw yield (t ha-1)						
13.Biproduct(kg)	1250	1325	1275.00	1350	1350	1275
14.Total Income	20815.00	21688.00	19938.00	21687.00	21250.00	20375.00
15.Net income/Loss	8915.00	10288.00	9087.00	10287.00	9170.00	8575.00

Note: Data presented for 50 decimal land, rice selling rate 17.50Tk/kg.

Table 48. Eeconomics of of DDSR boro rice at farmer`s field in Rangpur-2014

Input cost	Dulal	Alamgir	Faruk	Mannan	Anarul	Tulsi
1. Land Preparation	550.00	450.00	550.00	450.00	450.00	550.00
2. Layout/sowing	1200.00	1600.00	1400.00	1400.00	1600.00	1200.00
3. C. Fertilizer	1900.00	1790.00	1740.00	1840.00	1740.00	1800.00
4. Cow dung	1250.00	1000.00	1000.00	1000.00	1500.00	1000.00
5. Insecticide	750.00	750.00	700.00	500.00	800.00	900.00
6. Fungicide	450.00	500.00	450.00	400.00	300.00	450.00
7. Irrigation	1400.00	1250.00	1400.00	1500.00	1375.00	1500.00
8.Labour (inter.operation)	2300.00	1825.00	2100.00	1850.00	1800.00	1800.00
9. Labour (harvesting and cleaning)	1500.00	1850.00	1500.00	1300.00	1500.00	1750.00
10.Seed	400.00	400.00	300.00	400.00	400.00	400.00
Total cost	10490.00	11415.00	11110.00	10640.00	11465.00	11450.00
Output						
Grain yield (t ha^{-1})	6.15	5.03	5.05	4.94	5.74	4.94
Straw yield (t ha^{-1})	6.68	5.78	5.49	5.54	6.23	5.50
Total income	23855.00	18775.00	18905.00	18480.00	21390.00	18440.00
Net income/Loss	13360.00	9690.00	8190.00	8520.00	11125.00	8340.00

Note: Data presented for 50 decimal land, rice selling rate 17.50Tk/kg.

Table 49. Eeconomics of of puddle transplanted boro rice at farmers' field in Rangpur in 2014

Input cost	Dulal	Alamgir	Faruk	Mannan	Anarul	Tulsi
1. Land Preparation	750.00	650.00	750.00	800.00	850.00	750.00
2. Layout/ sowing	1450.00	1600.00	1400.00	1500.00	1600.00	1400.00
3. C. Fertilizer	1900.00	1790.00	1740.00	1850.00	1740.00	1900.00
4. Cow dung	-	-	-	-	-	-
5. Insecticide	750.00	500.00	600.00	600.00	750.00	400.00
6. Fungicide	280.00	280.00	280.00	250.00	280.00	280.00
7. Irrigation	2800.00	2700.00	2800.00	2800.00	2800.00	2900.00
8. Labourer (inter. operation)	1200.00	1350.00	1500.00	1200.00	1200.00	1250.00
9. Labour (harvest and cleaning)	1500.00	1650.00	1200.00	1300.00	1500.00	1500.00
10.Seed	400.00	400.00	400.00	400.00	400.00	400.00
11.Total cost	11030	10920.00	10670.00	10800.00	11120.00	10880.00
Output						
12.Rice production	1240 (6.20)	1180 (5.90)	1060 (5.30)	1100(5.50)	1190 (5.85)	1050(5.20)
13.Biproduct	1500	1350	1250	1300.00	1350	1275
15.Total income	23700.00	22650.00	20550.00	21250.00	22825.00	20375.00
Net income/Loss	12670.00	11730.00	9880.00	10450.00	11705.00	9495.00

Note: Data presented for 50 decimal land, rice selling rate 17.50Tk/kg.

Table 50. Eeconomics of of DDSR boro rice at farmer`s field in Rangpur-2015

Input cost	Dulal	Alamgir	Subal	Mannan	Anarul	Tulsi
Seed	2000.00	2000.00	2000.00	2000.00	2000.00	2000.00
Land Prepar	6625.00	6625.00	7250.00	7250.00	7250.00	7250.00
Sowing	7500.00	7500.00	6250.00	6250.00	7500.00	6250.00
Fertilizer	19625.00	17125.00	17525.00	17125.00	17375.00	16375.00
Pesticide	13400.00	12450.00	12700.00	11450.00	12700.00	10300.00
Irrigation	5000.00	6000.00	5500.00	6500.00	6500.00	6000.00
Labour(inter.op.	12500.00	12000.00	12500.00	10000.00	12750.00	9500.00
Labour(har. &oth.	10000.00	8750.00	9000.00	8750.00	10000.00	8750.00
Total cost	76650.00	72450.00	72725.00	69325.00	76075.00	66425.00
Output						
Product (tha^{-1})	5.950 101150.00	5.500 93500.00	5.255 89335.00	5.110 86870.00	5.680.00 96560.00	5.150 87550.00
Bi-product tha^{-1})	6.480 4860.00	5.940 5940.00	5.675 5675.00	5.579 5579.00	6.134 6134.00	5.562 5562.00
Total income	106010.00	99440.00	95010.00	92389.00	102694.00	93112.00
Net income	29360.00	26990.00	22285.00	23064.00	266190.00	26687.00

Note: Data presented for 1ha of land, rice selling rate 17.00Tk/kg

Table 51.Eeconomics of puddle transplanting boro rice cultivation at farmer`s field in Rangpur-2015

Input cost	Dulal	Alamgir	Subal	Mannan	Anarul	Tulsi
Seed	2000.00	2000.00	2000.00	2000.00	2000.00	2000.00
Seed bed prep.	2750.00	3250.00	3250.00	3750.00	3750.00	3750.00
Land Prepar	6625.00	6625.00	7250.00	7250.00	7250.00	7250.00
Transplanting	8750.00	8750.00	7500.00	8750.00	8750.00	8750.00
Fertilizer	20000.00	15200.00	16050.00	15200.00	16450.00	15200.00
Pesticide	6750.00	6800.00	67125.00	7400.00	7250.00	6800.00
Irrigation	15000.00	15000.00	15000.00	15000.00	16250.00	15500.00
Labour(inter.op.	15000.00	15000.00	15000.00	15000.00	15000.00	12500.00
Labour(har. &oth.	10000.00	8750.00	10000.00	8750.00	10000.00	8750.00
Total cost	86875.00	81375.00	83175.00	83100.00	86700.00	80500.00
Output						
Grain yield (tha^{-1})	6.00	5.75	5.500	5.38	5.80	5.46
Return from grain	102000.00	97750.00	93500.00	91375.00	98600.00	92905.00
Straw (tha^{-1})	6.525	6.210	5.940	5.805	6.372	5.902
Return from straw	4895.00	6210.00	5940.00	5805.00	6372.00	5902.00
Total income	106895.00	103960.00	99440.00	97180.00	104972.00	98807.00
Net income/Loss	22395.00	22585.00	16265.00	14080.00	18272.00	18307.00

Note: Data presented for 1 ha of land, rice selling rate 17.00Tk/kg

Table 52. Eeconomics of of DDSR boro rice at farmer`s field in Rajshahi-2015

Input cost	Insan Ali	Mainul	Rentu Mia	Saidur	Moniruzzaman	Toriqul Islam
Seed	2000.00	2000.00	2000.00	2000.00	2000.00	2000.00
Land Prepar	6000.00	6000.00	7000.00	6500.00	6850.00	7000.00
Sowing	62500.00	6900.00	7000.00	6750.00	6850.00	6500.00
Fertilizer	16115.00	16115.00	16115.00	16115.00	16115.00	19200.00
Pesticide	10750.00	10000.00	11300.00	11850.00	11350.00	10750.00
Irrigation	6500.00	7900.00	7900.00	6500.00	7300.00	9050.00
Labour(inter.op.	10600.00	10600.00	10800.00	12100.00	12300.00	10450.00
Labour(har. &oth.	9500.00	10000.00	9000.00	10400.00	10000.00	10000.00
Total cost	67715.00	69515.00	72115.00	72215.00	72765.00	74950.00
Output						
Product (tha^{-1})	5.378	5.500	5.618	5.715	5.708	5.903
Bi-product (tha^{-1})	5.808	5.940	6.067	6.172	6.165	6.375
	91426.00	93500.00	95506.00	97155.00	97036.00	100351.00
	5808.00	5940.00	6067.00	6172.00	6165.00	6375.00
Total income	97234.00	99440.00	101573.00	103327.00	103201.00	106726.00
Net income/Loss	29519.00	29925.00	29458.00	31112.00	30436.00	31776.00

Note: Data presented for 1ha of land, rice selling rate 17.00Tk/kg

Table 53. Eeconomics of puddle transplanting boro rice cultivation at farmer`s field in Rajshahi-2015

Input cost	**Insan Ali**	**Mainul**	**Rentu Mia**	**Saidur**	**Moniruzzan**	**Toriqul Islam**
Seed	2000	2000	2000	2000.00	2000.00	2000.00
Seed bed prep.	3950	4935	4900	4250.00	4500.00	4550.00
Land Prepar	6550	7000	7500	7500.00	7500.00	7500.00
Transplanting	8750	8320	9000	8000.00	8250.00	8350.00
Fertilizer	16125	16125	16125	16125.00	16125.00	19200.00
Pesticide	5500	5450	5350	5640.00	5300.00	5550.00
Irrigation	12500	12450	12350	12500.00	13650.00	14000.00
Labour(inter.op.	8500	9000	9000	9600.00	9600.00	8400.00
Labour(har. &oth.	9800	10500	11250	10500.00	10000.00	10500.00
Total cost	73675	75780	77475	76115.00	76925.00	80050.00
Output						
Product (tha^{-1})	5.55	5.60	5.74	5.69	5.76	5.92
Bi-product ($tha^{-1)}$	5.99	6.15	6.20	6.15	6.22	6.43
	94350	95200	97665	96815	97988	100606
	5994	6156	6205	6151	6225	6429
Total income	100344	101356	103870	102966	104213	107035
Net income/Loss	26669	25576	26395	26851.00	27288	26985

Note: Data presented for 1 ha of land, rice selling rate 17.00Tk/kg

Table 54. Cost Benefit ratio of Dry Direct Seeded boro rice cultivation of Participatory farmers' field in Rangpur -2015

Irrigation management	Grain Yield tha^{-1}	Biomass	Fixed cost	Variable cost	Total cost	Gross return	Gross margin	Net return	BCR
		yield tha^{-1}	(Tk ha^{-1})	(Tk ha^{-1})	(Tk ha^{-1})	(Tk ha^{-1})	(Tk ha^{-1})	(Tk ha^{-1})	
	1	2	3	4	5=(3+4)	6=(1+2)	7=(6-4)	8=(6-5)	9=(6/5)
Dulal	5.950(101150)	6.480(6480)	71650	5000	76650	107630	102630	30980	1.404
Alamgir	5.500(93500)	5.940(5940)	66450	6000	72450	99440	93440	26990	1.373
Subal	5.255(89335)	5.675(5675)	67225	5500	72725	95010	89510	22285	1.306
A.Mannan	5.110(86870)	5.579(5579)	62825	6500	69325	92389	85889	23064	1.333
Anarul	5.680(96560)	6.134(6134)	69575	6500	76075	102694	96194	26619	1.350
Tulsi	5.150(87550)	5.562(5562)	60425	6000	66425	93112	27045	26687	1.402

Table 55. Cost Benefit ratio of puddle transplanting boro rice cultivation of Participatory farmers'field in Rangpur -2015

	Grain	Biomass	Fixed cost	Variable cost	Total cost	Gross return	Gross margin	Net return	BCR
	Yield tha-1	yield tha-1	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	
	1	2	3	4	5=(3+4)	6=(1+2)	7=(6-4)	8=(6-5)	9=(6/5)
Dulal	6.00(102000)	6.525(6525)	71875	15000	86875	108525	93525	21650	1.249
Alamgir	5.750(97750)	6.210(6210)	66375	15000	81375	103960	88960	22585	1.278
Subal	5.500(93500)	5.940(5940)	68175	15000	83175	99440	84440	16265	1.196
A.Mannan	5.375(91375)	5.805(5805)	68100	15000	83100	97180	82180	14080	1.169
Anarul	5.800(96900)	6.156(6156)	70450	16250	86700	103056	86806	16356	1.189
Tulsi	5.465(91205)	5.791(5791)	65000	16150	81150	96999	80849	15849	1.195

Table 56. Cost Benefit ratio of Dry Direct Seeded boro rice cultivation of Participatory farmers' field in Rajshahi -2015

	Grain	Biomass	Fixed cost	Variable cost	Total cost	Gross return	Gross margin	Net return	BCR
	Yield tha-1	yield tha-1	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	
	1	2	3	4	5=(3+4)	6=(1+2)	7=(6-4)	8=(6-5)	
Insan Ali	5.378(91426)	5.808(5808)	61215	6500	67715	97234	90734	29519	1.436
Mainul	5.500(93500)	5.940(5940)	61615	7900	69515	99440	91540	29925	1.430
Rentu Mia	5.618(95506)	6.067(6067)	64215	7900	72115	101573	93673	29458	1.408
Saidur	5.715(97155)	6.172(6172)	65715	6500	72215	103327	96827	31112	1.431
Monirzamn	5.708(97036)	6.165(6165)	65465	7300	72765	103201	95901	30436	1.418
Toriqul	5.903(100351)	6.375(6375)	65900	8550	74450	106726	98176	32276	1.434

Table 57. Cost Benefit ratio of puddle transplanting boro rice cultivation of Participatory farmers' field in Rajshahi-2015

	Grain	Biomass	Fixed cost	Variable cost	Total cost	Gross return	Gross margin	Net return	BCR
	Yield tha-1	yield tha-1	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	(Tk ha-1)	
	1	2	3	4	5=(3+4)	6=(1+2)	7=(6-4)	8=(6-5)	
Insan Ali	5.550(94350)	5.994(5994)	62575	13500	76075	100344	87844	26669	1.319
Mainul	5.600(95200)	6.156(6156)	64730	13450	78180	101356	88906	25576	1.296
Rentu Mia	5.745(97665)	6.205(6205)	65525	13350	79875	103870	90520	23995	1.300
Saidur	5.695(96815)	6.151(6151)	64615	13500	78115	102966	89466	24851	1.318
Monirzamn	5.764(97988)	6.225(6225)	64675	13650	78325	104213	90560	25888	1.330
Toriqul	5.918(100606)	6.429(6429)	66050	14000	80050	107035	93035	26985	1.337

Agronomic performance and economics of different cropping Patterns

The field duration of Binadhan-7 was 96 days while the existing rice cv. Sharna had the field duration of 115 days. The mustard should be sown during mid October to first week of November which can be done by cultivating Binadhan-7 while the harvesting would be delayed in sharna is cultivated. The yield of Binadhan-7 was higher (4.88 t ha^{-1}) than Sharna (4.41 t ha^{-1}). In respect to yield and field duration Binadhan-7 is the best replacement for local aman rice Sharna. Most of the farmers use T. aman – Fallow – PTR boro cropping pattern in both the locations, particularly in Rajshahi. The rice equivalent yield at Rajshahi in 2013-14 for T. aman – Fallow – PTR boro, T. aman – Mustard – PTR boro and T. aman – Mustard – DDS boro were 10.34, 13.64 and 13.46 t. , respectively. In both the locations during the two cropping were similar result was found that rice equivalent in both the three crop pattern was higher than the existing two crop pattern. In Rajshahi the gross margin for T. aman – Fallow – PTR boro, T. aman – Mustard – PTR boro and T. aman – Mustard – DDS boro were 55565, 86162, and 88401 Tk ha^{-1}, respectively indicating that dry direct seeded pattern is more profitable than the other two patterns. The MBCR value for dry direct seeded based pattern is higher (2.50) than puddle transplanted based cropping pattern (2.08) indicating the superiority of the dry direct seeded based three crop pattern. Thus the study clearly indicated that the dry direct seeded boro rice based cropping pattern has much more economic efficiency than the existing cropping pattern in both the geographical areas.

Table 58. Field duration, yield and economics of crops under three cropping patterns in Rajshahi site during 2013-14.

Items	DDS Boro rice based pattern			PTR Boro rice based pattern			Existing cropping pattern		
Crop	**T.aman**	**Mustard**	**DDS boro**	**T.aman**	**Mustard**	**T. boro**	**T.aman**	**Fallow**	**PTR-CI boro**
Variety	**Bina dhan-7**	**BARI sarisha14**	**BRRI dhan28**	**Bina dhan-7**	**BARI sarisha14**	**BRRI dhan28**	**Sharna**	**-**	**BRRI dhan28**
Sowing Time /Transplanting	16.07.2013	08.11.2013	19.02.2014	16.07.2013	08.11.2013	19.02.2014	24.07.2013		17.01.2014
Harvesting	20.10.2013	06.02.2014	16.06.2014	20.10.2013	06.02.2014	05.06.2014	15.11.2013		20.05.2014
Field Duration(Days)	96	90	119	96	90	106	115		123
Grain yield (tha^{-1})	4.88	1.45	5.17	4.88	1.45	5.35	4.41		5.93
Stover yield(tha^{-1})	5.32	1.79	5.62	5.32	1.79	5.74	4.85		6.44
Rice equivalent yield (t/ha/yr)	13.46			13.64			10.34		
Gross return (Tk/ha)	242776			247099			188013		
Total variable cost (Tk/ha)	154375			160937			132448		
Gross margin (Tk/ha)	88401			86162			55565		
MVP	54763			59086			-		
MVC	21927			28489			-		
MBCR	2.50			2.08			-		

Table 59. Field duration, yield and economics of crops under three cropping patterns in Rajshahi site during 2014-15.

Items	DDS Boro rice based pattern			PTR Boro rice based pattern			Existing cropping pattern		
Crop	**T.aman**	**Mustard**	**DDS boro**	**T.aman**	**Mustard**	**T. boro**	**T.aman**	**Fallow**	**PTR-CI boro**
Variety	**Bina dhan-7**	**BARI sarisha14**	**BRRI dhan28**	**Bina dhan-7**	**BARI sarisha14**	**BRRI dhan28**	**Sharna**	**-**	**BRRI dhan28**
Sowing Time /Transplanting	16.07.2014	26.10.2014	09.02.2015	16.07.2014	26.10.2014	09.02.2015	20.07.2014		13.01.2015
Harvesting	19.11.2014	23.01.2015	07.06.2015	19.11.2014	23.01.2015	24.05.2015	11.11.2014		15.05.2015
Field Duration	95	88	118	95	88	104	114		122
Grain yield (tha-1)	5.04	1.32	5.64	5.04	1.32	5.71	4.32		5.91
Stover yield(tha-1)	5.49	1.73	6.08	5.49	1.73	6.19	4.75		6.32
Rice equivalent yield (t/ha/yr)	13.96			13.85			10.10		
Gross return (Tk/ha)	252759			251224			184199		
Total variable cost (Tk/ha)	159609			163437			134423		
Gross margin (Tk/ha)	93150			87787			49776		
MVP	68560			67025					
MVC	25186			29014					
MBCR	2.72			2.31			-		

Table 60. Field duration, yield and economics of crops under three cropping patterns in Rangpur site during 2013-14.

Items	DDS Boro rice based pattern			PTR Boro rice based pattern			Existing cropping pattern		
Crop	T.aman	Mustard	DDS boro	T.aman	Mustard	T. boro	T.aman	Fallow	PTR-CI boro
Variety	Bina dhan-7	BARI sarisha14	BRRI dhan28	Bina dhan-7	BARI sarisha14	BRRI dhan28	Sharna	-	BRRI dhan28
Sowing Time /Transplanting	16.07.2013	07.11.2014	13.02.2014	16.07.2013	07.11.2014	13.02.2014	22.07.2013		15.01.2014
Harvesting	18.11.2013	04.02.2014	09.06.2014	18.11.2013	04.02.2014	31.05.2014	12.11.2013		17.05.2014
Field Duration(Days)	94	89	116	94	89	107	114		122
Grain yield (tha-1)	4.99	1.49	5.48	4.99	1.49	5.57	4.25		5.98
Stover yield(tha-1)	5.43	1.96	5.93	5.43	1.96	6.07	4.69		6.31
Rice equivalent yield (t/ha/yr)	13.67			14.05			10.10		
Gross return (Tk/ha)	247375			254677			184199		
Total variable cost (Tk/ha)	159860			161179			134423		
Gross margin (Tk/ha)	97515			93498			49776		
MVP	63176			70478					
MVC	25437			26756					
MBCR	2.48			2.63					

Table 61. Field duration, yield and economics of crops under three cropping patterns in Rangpur site during 2014-15.

Items	DDS Boro rice based pattern			PTR Boro rice based pattern			Existing cropping pattern		
Crop	**T.aman**	**Mustard**	**DDS boro**	**T.aman**	**Mustard**	**T. boro**	**T.aman**	**Fallow**	**PTR-CI boro**
Variety	**Bina dhan-7**	**BARI sarisha14**	**BRRI dhan28**	**Bina dhan-7**	**BARI sarisha14**	**BRRI dhan28**	**Sharna**	**-**	**BRRI dhan28**
Sowing Time /Transplanting	15.07.2014	02.11.2014	09.02.2015	15.07.2014	02.11.2014	09.02.2015	20.07.2014		15.01.2015
Harvesting	19.10.2014	27.01.2015	05.06.2016	19.10.2014	27.01.2015	21.05.2016	10.11.2014		16.05.2015
Field Duration	96	86	116	96	86	101	113		120
Grain yield (tha-1)	4.93	1.47	5.44	4.93	1.47	5.65	4.30		5.92
Stover yield(tha-1)	5.37	1.89	5.89	5.37	1.89	6.13	4.94		6.37
Rice equivalent yield (t/ha/yr)	13.83			14.04			10.34		
Gross return (Tk/ha)	248310			251458			185732		
Total variable cost (Tk/ha)	163415			164869			133777		
Gross margin (Tk/ha)	84895			86589			51954		
MVP	62578			65726					
MVC	29638			31092					
MBCR	2.17			2.11					

Table 62. Field duration, yield and economics of crops under three cropping patterns for the up-scaling farmer in Rangpur site during 2015-16.

Items	DDS Boro rice based pattern			Existing cropping pattern		
Crop	**T.aman**	**Mustard**	**DDS boro**	**T.aman**	**Fallow**	**PTR-CI boro**
Variety	**Bina dhan-7**	**BARI sarisha14**	**BRRI dhan28**	**Sharna**	**-**	**BRRI dhan28**
Sowing Time /Transplanting	18.07.2015	07.11.2015	10.02.2016	18.07.2015		10.02.2016
Harvesting	20.10.2015	05.02.2016	31.05.2016	13.11.2016		31.05.2016
Field Duration	95	90	110	119		129
Grain yield (tha-1)	4.89	1.62	5.60	4.60		5.97
Stover yield(tha-1)	5.03	2.09	5.74	4.81		6.08
Rice equivalent yield (t/ha/yr)	14.30			10.57		
Gross return (Tk/ha)	218903			170618		
Total variable cost (Tk/ha)	144019			126393		
Gross margin (Tk/ha)	74884			44225		
MVP	48285					
MVC	17626					
MBCR	2.74					

7. Irrigation water saving from dry direct seeding

Boro rice cultivation under dry direct seeded (DDS) and puddle transplanted (PTR) systems required 582 mm and 1945 mm in 2014 at Rangpur site while those were 875 mm and 1589mm in Rajshahi sites, respectively. In 2015, 731 mm and 1632 mm irrigation water applied in 12 and 25 events in dry direct seeded (DDS) and puddle transplanted (PTR) Rangpur site. In Rajshahi site the irrigation requirements for DDS and PTR were 1064 mm and 1514 mm, respectively for DDS and PTR system applied in 11 and 16 events. The water saving was 45% and 70% respectively in Rajshahi and Rangpur sites in 2014. On the other hand, in 2015 boro season the water saving for DDS at Rajshahi and Rangpur were 30% and 55%, respectively. Irrespective of the site and soil on an average 54% water saving was recorded in dry direct seeded crop compared with puddled transplanted rice.

Table 63. Frequency and amount of irrigation required in DDSR and PRT-CI methods in Rajshahi site during boro season -2014

Farmers'	DDSR		PTR-CI		Water saving (%)
	Frequency	Amount (mm)	Frequency	Amount (mm)	
Md.Ahad Ali	9	867	16	1605	46
Nasir Uddin	8	872	16	1580	45
Tufazzal	8	905	15	1645	45
Nur Hossain	9	880	17	1570	44
Zillur Rahman	9	840	17	1525	45
Toriqul Islam	9	885	17	1610	45

Table 64. Frequency and amount of irrigation required in DDSR and PRT-CI methods in Rangpur site during boro season-2014

Farmers' name	DDSR		PTR-CI		Water saving (%)
	Frequency	Amount (mm)	Frequency	Amount (mm)	
Dulal	8	560	24	1715	68
Alamgir	9	580	26	1930	70
Faraque	9	570	25	1775	68
Mannan	9	610	27	2095	71
Anarul	10	585	28	2090	72
Tulsi	9	578	28	2065	72

Table 65. Frequency and amount of irrigation required in DDS and PRT methods in Rangpur site during boro season-2015

Farmers' name	DDSR		PTR-CI		Water saving (%)
	Frequency	Amount (mm)	Frequency	Amount (mm)	
Dulal	9	675	22	1675	60
Alamgir	12	750	27	1650	55
Subal	10	690	24	1625	60
Mannan	13	725	27	1635	55
Anarul	13	842	27	1680	50
Tulsi	12	705	27	1532	55

Note: DDSR = Dry direct seeded rice, PTR-CI = Puddle transplanted rice with conventional irrigation, water saving (%) = the amount less compared with PTR-CI

Table 66. Frequency and amount of irrigation required in DDSR and PRT-CI methods in Rajshahi site during boro season -2015

Farmers' name	DDSR		PTR-CI		Water saving (%)
	Frequency	Amount (mm)	Frequency	Amount (mm)	
Insan	12	1050	16	1480	30
Mynul	11	992	16	1450	32
Rintu	12	1075	15	1484	28
Saidur	11	1092	16	1550	30
Monir	11	1050	16	1510	30
Toriqul	12	1125	17	1610	31

Table 67. Frequency and amount of irrigation required in DDSR and PRT-CI methods in Rangpur site during boro season-2015

Farmers' name	DDSR		PTR-CI		Water saving (%)
	Frequency	Amount (mm)	Frequency	Amount (mm)	
Dulal	9	675	22	1675	60
Alamgir	12	750	27	1650	55
Subal	10	690	24	1625	60
Mannan	13	725	27	1635	55
Anarul	13	842	27	1680	50
Tulsi	12	705	27	1532	55

Table 68. Frequency and amount of irrigation required in DDSR and PRT-CI methods in Rajshahi site during boro season -2015

Farmers' name	DDSR		PTR-CI		Water saving (%)
	Frequency	Amount (mm)	Frequency	Amount (mm)	
Insan	12	1050	16	1480	30
Mynul	11	992	16	1450	32
Rintu	12	1075	15	1484	28
Saidur	11	1092	16	1550	30
Monir	11	1050	16	1510	30
Toriqul	12	1125	17	1610	31

Farmers's Training

Farmer's training was conducted on dry direct seeded boro rice production technology during 8 and 9 February 2014 in Rangpur and 10 and 11 February 2014 in Rajshahi sites. Each batch of training consisted of 25 participants comprising the 3 participatory farmers and 21 associated farmers from the area. The training was held at Haridebpur and Lahirir Hat in Rangpur while that was conducted at Rajabari and Kakonhat at Godagari, Rajshahi. Training was given on the ground following principle of learning by doing method. After delivering a lecture about prospects of the dry direct seeded boro rice based cropping system by the Principal Investigator, the different resources persons took their sessions on seed sowing technology, fertilizer and water management, weed and pest management of dry direct seeded boro rice. The participating farmers learned the technique of seed priming and the sowing technology practically. Farmers showed keen interest in learning the new technology.

Focus Group Discussion (FGD)

A baseline survey on different existing cropping patterns and farmer's attitude towards the existing cropping practices and water use in rice production was conducted through FGD on 13 March at Haridebpur, Sadar, Rangpur and 15 March at Kadipur, Kakonhat, Godagari, Rajshahi. Fifty farmers participated in the FGD and they were divided into five sub-groups. Each sub-group was assigned to list the name of crops and their varieties in Rabi, Kharif-I and Kharif-II seasons to findout the existing cropping pattern being practiced by them and their neighbours. Each sub-group also calculated the cost of production and return from their cropping practices. They discussed about irrigation situation and its relationship with cropping practices through brain storming and practical experience. After performing the practical works each sub-group presented their reports. During their report presentation more than 19 cropping patterns were listed in Rajshahi while it was more than 17 in Rangpur. The existing cropping patterns were ranked on the basis of their area coverage (Table). It was also found that scarcity of irrigation water in boro season in both the location was very acute because of the draw down of water table and also due to load shading of the electricity. Farmers reported that most of them prefer to grow boro rice after T. Aman but water shortage is the major barrier to their cropping practices.

Through FGD it was found that different rice varieties are grown in Aman season. The rice varieties in Aman season in Godagari, Rajshahi occupying the area were in the order of Guti Sharna>Suman Sharna>BRRI dhan34> BINA dhan7>BRRI dhan49 while the rice grown in the Sadar upazilla of Rangpur was in the order of Guti Sharna>BINA dhan7> BR11>BRRI dhan33>BRRI dhan49>BRRI dhan57>BRRI dhan57. The major rice varieties grown in boro season at Rajshahi is in the order of BRRI dhan28>BRRI dhan28>Hybrid rice >Minicate>Pariza>BINA dhan7 while those in Rangpur are in the order of BRRI dhan28>Hybrid. The rabi crops grown in Rajshahi are Mustard, Wheat, Tomato, Cabbage, Potato, Garden pea, Maize, Chickpea, Lentil, Onion, Garlic etc. while the rabi crops at Rangpur are Potato, Mustard, Wheat, Maize, Tobacco, Cabbage, Carrot, Eggplant, Tomato, Onion, Garlic etc. The farmers realized that

they feel secured when they can grow rice for their food especially in boro season. At the end of the three years project period farmer's attitude towards dry direct seeded boro rice based cropping system was again studied through FGD. The opinions of the farmer's of the study area about the advantages, disadvantages and future prospect of the dry direct seeded boro rice based cropping pattern have been stated below.

Table 69. The Major cropping pattern in project areas at Rajshahi and Rangpur

Sl. No.	Rajshahi	% area	Sl. No.	Rangpur	% area
1.	T. Aman - Fallow - Boro	35	1.	T Aman-Fellow-Boro	38
2	T. Aman – Boro - Aus	12	2	T Aman –Potato –Boro	12
3	T. Aman- Fallow – Aus	10	3	T. Aman-Tobacco – T. Aus	11
4	T. Aman – Wheat – Aus	8	4	T. Aman-Mustard-Boro	7
5	T. Aman – Wheat – Fallow	7	4	T Aman –Boro –Aus	6
6	Blackgram –Boro- Aus	5	5	T Aman – Wheat –Jute	4
7	T. Aman – Mustard – Fallow	2	6	T Aman – Potato –Aus	2
8	Tomato – Fallow – T. Aus	2	7	T Aman- Potato -Maize	2
9	Fallow – Aus – Mustard	2	8	T. Aman-Cabbage-Boro	1
10	Fallow – Aus – Boro	2	9	Jute-Tomato-Fallow	1
11	T. Aman – Maize – Aus	2	10	T. Aman-Tomato-Fallow	1
12	T. Aman – Onion – Aus	1	11	T. Aman – Pulse crop - Fallow	1
13	T. Aman – Mustard - Boro	1	12	T. Aman-Maize-Fallow	1
14	Tomato – Boro – Fallow	1	13	Vegetable-Boro –Fellow	1
15	Tomato-Boro-Aus	1	14	Eggplant – Boro - Fallow	1
16	Tomato-Boro-Fallow	1	15	T. Aman– Tobacco- Maize	1
17	T. Aman –Chickpea-Fallow	1	16	T. Aman–Sugarcane + vegetables	1
18	T. Aman –Lentil-Fallow	1	17	Others	9
19	Others	6			

Table 70. Varieties of rice in aman and boro seasons and different rabi crops grown in Rajshahi and Rangpur		
Season/ Crops	Rajshahi	Rangpur
Aman rice	Guti sharna> Suman sharna>BRRI dhan 34> BINAdhan7> BRRI dhan 49	Guti Sharna> BINA dhan7>BR11>BRRI dhan49>BRRI dhan56> BRRI dhah57
Rabi crops	Mustard, wheat, tomato, cabbage, potato, garden pea, maize, chickpea, lentil, onion, garlic etc.	Potato, mustard, wheat, maize, tobacco, cabbage, carrot, eggplant etc.
Boro rice	BRRI dhan28> BRRI dhan29>Hybrid rice>Minicate> Pariza> BINA dhan7	BRRI dhan28> Hybrid rice

Advantages of Dry Direct Seeding in Boro season

- Less irrigation requirement (50-60% than PTR-CI)
- Less labour requirement for sowing (25 in DDS vs 40 per ha in PTR-C)
- DDS gives higher yield than PTR-C boro rice.
- DDS boro rice system creates scope for rabi crop cultivation after T. aman rice.
- Fresh straw of early T. aman rice gives an additional income from the new cropping pattern.

Problems of DDS in Boro season

- Higher weed infestation and weeding cost
- Deep tube well owners give less priority for irrigation to the DDS rice plots.
- More insect infestation due to lack of crops in the field due to late cropping.
- Sometimes infestation by the birds.
- Longer field duration of DDS crops than transplanted crop.

Solutions to the problems

- Judicious use of herbicides
- Proper integration of different methods of weed control
- Clean cultivation
- Attitudinal change in weed management
- Community based cropping practices should be adopted
- Motivational training and mass media communication
- Policy formulation at local level
- Availability of mechanical seeder for easy and rapid sowing to lowering the seeding costs.

(i) List of objective-wise activities clearly, resulting in specific output(s)

Specific Project Objective(s)	**Planned activities performed against each objectives**	**State progress made clearly during the reporting period against each activity**	**Outputs/results achieved during this period**
1. To adapt dry direct seeded (DDS) Boro rice and to improve system productivity of T. Aman-Mustard-DDS Boro rice with less irrigation water.	1.1. Site and farmers selection 1.2. Baseline survey of existing cropping system 1.3. Collection of soil sample and their analysis 1.4. Organizing inception workshop 1.5. Organizing farmers training 1.6. Conducting T. Aman trials, collection of relevant key data and their analysis. 1.7. Conducting Rabi crop trials, collection of relevant key data and their analysis. 1.8. Conducting boro rice trials under DDSR and PTR-CI system, collection of relevant key data and their analysis.	1.1. Site and farmers selection completed. 1.2 Baseline survey completed. 1.3. Soil samples collected and their analysis done. 1.4. Inception workshop was not conducted due to unavoidable reasons. 1.5. Farmers training on dry direct seeded boro rice production technology completed. 1.6. T. aman trials conducted. 1.7. Rabi crops (mustard) trials completed. 1.8. Boro rice trials using DDS and PTR systems completed.	1.1. Major cropping patterns and crop varieties in two tiral sites identified. 1.2. Short duration rice variety Binadhan7 gives higher yield than existing local varieteis and allows timely cultivation of mustard. 1.3. Mustard variety BARI sharisha gave satisfactory yield and allows sowing of boro rice at optimum time. 1.4. DDS boro rice gives better yield than the PTR-CI boro rice.
2. To save irrigation water and thereby to reduce cost of boro rice production.	2.1. Collection of quantitative data on irrigation water use with cost for DDSR boro rice.	2.1. The amount of irrigation water applied in the field was measured and recorded.	2.1. DDSR boro rice required 50 and 60% less irrigation water compared with PRC-CI boro rice in Rajshahi and Ranpur sites, respectively.
3. To popularize the new crop production system among the farmers of the project upazillas.	3.1 Conducting field day for DDSR boro rice. 3.2 Awareness building through printing and media	3.1. The field day on DDS held both in Rangpur and Rajshahi locations. 3.2 The results published through printing and electronic media.	3.1. Farmers of both the location became aware of the T. aman –Mustard – DDS .
4. .To improve knowledge and skill of the farmers and extension workers and to create awerness among the farmers of the project area on the improved crop production system particularly on DDS Boro rice.	4.1 Organizing result sharing workshop 4.2 Organizing field days. 4.3 Preparation and distribution of leaflet among the relevant farmers. 4.4 Result sharing with the mass media. 4.5 Holding concluding seminar.	4.1-2. Result sharing workshop was not conducted due to unavoidable reasons. 4.3-4.4 Reported by the electronic and print media. 4.5. Concluding seminar on the result of the project held.	4.Farmers skill developed on the technology and the different stakeholders became aware of the technology.

(ii) Outputs/Results:

1. T. Aman – Mustard – DDS boro cropping pattern developed with 30% higher productivity.
2. Irrigation water saved by more than 50% and production cost reduced by 5%.
3. Farmer's knowledge and skill on production technology of T. Aman – Mustard – DDS boro rice improved.

(iii) Benefit/Outcome:

1. Dry direct seeded boro rice production system is a climate resilient environment friendly technology that enables farmers to produce rice with less than 50% irrigation water.
2. Adoption of the T. Aman – Mustard – DDS boro rice cropping pattern helps increasing productivity by 30%.
3. The use of diesel and electricity for irrigation will be reduced by about 50% which will reduce greenhouse gas emission accordingly.

d. Technology Developed :

T. Aman –Mustard – Dry Direct Seeded Boro cropping pattern developed.

e. Publications made/under process:

Three scientific articles are under preparation for publication in different journals. The titles of these articles are:

(d) Productivity of dry direct seeded boro rice based cropping pattern in water short areas of Bangladesh

(e) Selection of short duration aman rice varieties for drought prone areas of Bangladesh through farmer's participatory trial.

(f) Selection of rice varieties for dry direct seeding in drought prone areas of Bangladesh through farmer's participatory trial.

f. Training/workshop organized:

Trainings of 4 batches (each 25 farmers) of farmers were organized.

g. Graduate Studies:

One Ph. D. student was involved who is going to submit the thesis by December 2016.

h. Linkages Developed:

A network with different research institutes, government organizations and farmers community has been developed because of the activities carried out under this project.

i. Equipments/Appliances Purchased:

One Lap top and a camera were purchased under this project.

F. Highlight of Research Findings

i. The existing long duration aman rice variety (Guti Sharna) can be replaced with a short duration variety (BINA dhan7, BRRI dhan56 or BRRI dhan57) and this will allow cultivation of mustard (variety BARI sharisha14) successfully before boro rice (cv. BRRI dhan28 and BRRI dhan58).

ii. There was no yield difference of rice (cv. BRRI dhan28 or BRRI dhan58) under dry direct seeded and puddled transplanted systems.

iii. The total rice production from Aman and Boro seasons remained comparable for T. aman - Fallow- T. Boro and T. aman –Mustard – T. Boro/ DDS boro patterns. Moreover, an additional yield of mustard (about 1.5 t ha^{-1}) can be obtained from the latter pattern.

iv. The newly introduced T. aman – Mustard – DDSR boro cropping pattern creates an opportunity of growing two rice crops successfully with an additional rabi crop using less than 50% irrigation water.

G. Conclusion:

i. Dry direct seeding method saves more than 50% irrigation water for boro rice cultivation. Thus, it reduces more than 50% electricity and diesel consumption for irrigation purposes.

ii. Boro rice can be sown during early to mid February that paves the room for cultivation of rabi crops (mustard/potato/cabbage) after T. aman rice.

iii. The total to rice productivity from T. aman-Mustard – DDS boro pattern is similar to that of the existing T. Aman-Fallow – T. Boro pattern. Thus, introduction of the new pattern will have no negative impact on total annual rice production.

iv. The new cropping pattern will create an opportunity of successful cultivation of mustard in addition to the T. aman and Boro rice.

v. BRRI dhan28 and BRRI dhan58 can be used in boro season for February sowing. However, in high temperature areas BRRI dhan58 can be used instead of BRRI dhan28.

vi. Community based block demonstration and mass motivational drive can be in place to enhance adoption of this water saving crop production system for ensuring food security in the country.

H. Recommendation:

i. T. aman – Mustard – DDS boro rice pattern can be adopted for sustaining rice production using less than 50% irrigation water.

ii. Community based block demonstration and mass motivational drive should be taken to enhance adoption of this technology.

iii. Power operated seeder with distant dibbling facilities needs to be developed for easy and economic sowing.

I. Financial Statement: Fund received and Expenditure made during the reporting period (20 May 2013 to 30 June 2016)

1.1 Summary statement of Expenditure (SoE)

1.2 Component wise budget & SoE: Must provide separate SoE against approved budget for each component /partner using the format given below:

Particulars/Line Items										
		A. Fund Received in Installment								**Actual Fig. Tk. in thousand**
1st install.	**2nd Install.**	**3rd install.**	**4th Install.**	**5th install.**	**6th install.**	**7th Install.**	**8th Install.**	**9th Install.**	**10th Install.**	**Total**
559.10	**838.65**	**698.875**	**200.00**	**887.575**	**660.79**	**300.00**	**815.40**	**815.40**	**815.40**	**6591.19**

Sl. No.	**Particulars/Line Items**	**Approved Total Budget**	**Exp. Up to previous Report (From June 13 to November 15)**	**Current Exp. (Reporting period) From December to 15 June/16**	**Cumulative Exp.Tk**	**Rest of Budgeted Amount**
	B. I. Expenditure: Recurring (Operational cost)	1	2	3	4=(2+3)	5=(1-4)
1.	1.1 Remuneration for Contractual Staff (Research Fellow/Res. Associate, Res. Asstt./Field Asstt; consolidated)	**1440.00**	**1105.00**	**220.00**	**1325.00**	**115.00**
	1.2 Remuneration of Accounting /Typing Support Service, if any (part time basis- consolidated)	**108.00**	**90.00**	**21.00**	**111.00**	**-3.00**
2.	2.1 Research & Development (R&D) related cost i.e. all inputs, lab./ farm chemicals & other necessary supplies etc. 2.2 Contractual Services	**2984.50**	**2593.109**	**388.496**	**2981.605**	**2.895**
3.	Maintenance and repairing of lab. /field equipment, etc.	**70.00**	**69.989**	**-**	**69.989**	**0.011**
4.	Training	**100.00**	**100.00**	**-**	**100.00**	**0**
5.	Workshop/Seminar/Meeting etc.	**111.00**	**-**	**45.00**	**45.00**	**66.00**
6.	6.1 Travel expenses (TA/DA) as per own organizational rules (Public Sector) or as per KGF Rules (Non-govt.Org).	**480.00**	**396.685**	**76.889**	**473.574**	**6.426**
	6.2 Vehicle hiring/oil & fuel for organization's vehicle for travel, if justified.	**594.00**	**472.728**	**114.654**	**587.382**	**6.618**
7.	Office supplies and contingency (not exceeding 15% of the total cost for stationeries, publications, printing of reports, internet, service, mailing etc.)	**315.00**	**236.7**	**78.3**	**315.00**	**0**

Particulars/Line Items		Approved Total Budget	Exp. Up to previous Report (From June 13 to November 15)	Current Exp. (Reporting period) From December to 15 June/16	Cumulative Exp.Tk	Rest of Budgeted Amount
8.	Field day	**150.00**	**100.00**	**50.00**	**150.00**	**0**
9.	Institutional Overhead Charge (if any, max 10% of total operating cost)	**350.00**	**240.00**	**110.00**	**350.00**	**0**
B.I. Sub-total B.I (1-9)		**6702.50**	**5404.211**	**1104.339**	**6508.55**	**193.95**
B. II: Non-recurring (Capital cost)						
10.	Equipment & Appliances (upon approval of KGF) 10.1. Lab. and Field Equipment 10.2. Office Equipment	**75.00**	**74.70**	**-**	**74.700**	**0.300**
B.II. Sub-total (10)		***75.000***	***74.700***	**-**	***74.700***	***0.300***
Grand Total Expenditure: GT(B.I+B.II)		**6777.5**	**5478.911**	**1104.339**	**6583.25**	**194.25**

Balance (A-GT) **(6591.19 – 6583.25)= 7.940** Financial progress : (a) Fund Received in Tk**6591.19**	as per Bank Statement =**7.940** **(**Thousand**)** TK**.**	(b)Fund utilized as per SoE in Tk**6583.25** % achieved=(6583.25/6591.19) ×100 =99.88 ..... Signature of PI with seal

J. Self Assessment of the Project:

1. Have you been able to achieve all specific objectives of your project? Yes

2. Who is / are the target beneficiary group/s of your project output/result? Farmers

3. How the project outputs/results obtained would benefit the target beneficiary group/s? and how these could be transferred to the that/those target group/s?

The adoption of the new cropping pattern (T. Aman-Mustard-DDS boro) would create an opportunity of growing an additional rabi crop (such as mustard, cabbage, potato etc.) in addtion to two rice crops. This practice would reduce production cost through reduction of irrigation by about 50% resulting in increased total farm productivity and economic return. This technology could be transferred to the target beneficiary groups through massive demonstration followed intensive motivational drive.

4. Do you think that you have successfully completed the project? Yes/No. If yes, please provide one page success story/communication brief of your project in simple language with relevant pictures where applicable.

Yes, success story has been enclosed.

5. Please describe briefly the outcomes/benefit and likely impact of your project on the productivity, policy, society, economy and environment.

i. The total rice production from Aman and Boro seasons remains comparable for T. aman - Fallow- T. Boro and T. aman –Mustard – T. Boro/ DDS boro patterns. Moreover, an additional yield of mustard (about 1.5 t ha^{-1}) can be obtained from the new pattern.

ii. This new cropping pattern creates an opportunity of growing crops with high producity with less than 50% irrigation compared with the conventional practices.

iii. The use of less irrigation means saving of fuel and electricity by about 50% that would contribute to reduce green house gas emission by half of the present situation.

iv. The adoption of the new cropping pattern will create a window to cultivate diversified crops even in the drought prone areas contributing to maintain food security.

v. This cropping pattern will create more employment opportunities for the farming community because of introduction of an additional crop and will also contribute to the women empowerment.

K. Acknowledgement:

I am highly grateful to the KGF authority for their financial and technical supports throughout the project period without which it would never be possible to accomplish the project work successfully. I am also thankful to the BAURES authority for their kind support and administrative help for implementing the project activities in time. I also gratefully acknowledge the help and cooperation received from the Head, Department of Agronomy, BAU during the project period. The project implementation would not be possible without the kind help and continuous support of the DAE personnels of the project area, I am highly grateful to all of them. I would like to express my thanks and gratitude to the members of my research team as well as other participants for their cooperation in different project activities. The contributions of the electronic and print media personnels are gratefully acknowledged for bringing the success story to the mass people.

L. Endorsement:

Principal Investigator (PI)

Head of Organization/Authorized Person