Project ID: 672

Competitive Research Grant

Sub-Project Completion Report

on

Productivity Enhancement through Adaptation of Improved Crop Production Technologies in Previous Enclaves of Northern Region of Bangladesh

Project Duration

May 2017 to September 2018

On-Farm Research Division
Bangladesh Agricultural Research Institute

Submitted to
Project Implementation Unit-BARC, NATP-2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Bangladesh Agricultural Research Council (BARC)
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Acronyms

AEZ	:	Agro-ecological zone
BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agricultural Research Institute
BCR	:	Benefit cost ratio
BHM	:	BARI Hybrid Maize
BINA	:	Bangladesh Institute of Nuclear Agriculture
BJRI	:	Bangladesh Jute Research Institute
BRRI	:	Bangladesh Rice Research Institute
CP	:	Cropping Pattern
Co-PI	:	Co-Principal Investigator
DAE	:	Department of Agriculture Extension
DAP	:	Days After Planting
DAS	:	Days After Sowing
DAT	:	Days After Transplanting
FRG'12	:	Fertilizer Recommendation Guide-2012
FP	:	Farmers practice
GM	:	Gross margin
GR	:	Gross return
IPNS	:	Integrated Plant Nutrition System
NARIs	:	National Agricultural Research Institutions
NATP	:	National Agricultural Technology Program
OFRD	:	On-Farm Research Division
PI	:	Principal Investigator
Rec.	:	Recommended
REY	:	Rice equivalent yield
SRDI	:	Soil Resource Development Institute
TVC	:	Total variable cost

Table of Contents

Executive Summary

Traditional agricultural practices are the major hindrance for crop productivity in the previous enclaves (Chhitmohal). Being detached from the mainland, the previous enclaves' population was engaged only in subsistence farming with low agricultural productivity and restricted access to inputs. The National Agricultural Research Institutions (NARIs) have developed a number of excellent improved technologies, which may enhance the crop productivity in these areas. From these views, the project was undertaken in three previous enclaves i.e. Dasiarchhara in Kurigram; Dahalakhagrabari in Panchagarh and Banskata in Lalmonirhat districts by OFRDI, Rangpur under NATP Phase-II.

Baseline survey was conducted with 105 farmers in three previous enclaves following Random sampling technique. It was revealed that majority of the sample farmers' cultivated local variety of crops with indiscriminate doses of fertilization. Most of the farmers engaged only in subsistence farming with low agricultural productivity. In the three previous enclaves, long duration T.Aman rice (var. Swarna)hampered to grow rabi crops successfully. T.Aman–Fallow–Boro, T.Aman–Fallow–Maize and T.Aman-Fallow-Groundnut were the major cropping patterns in Dasiarchhara, Banskata and Dahalakhagrabari, respectively. Lack of knowledge about new crop varieties/technologies was the main constraint due to totally excluded from development activities of both government and non-government organizations.

From the varietal trials with potato (BARI Alu-25, 46 and 53) and mustard (BARI Sarisha-14, 15 and 17), it was revealed that farmers mainly chose BARI Alu-53 and BARI Alu-25 due to their red skin color. The average performance of BARI Sarisha-14 was relatively better than others across the locations.

On the basis of existing cropping patterns and farmers choice, the selected alternative/improved cropping patterns were CP1= T.Aman (var. BRRI dhan 49)-Mustard (var. BARI Sarisha-14)-Boro (var. BRRI dhan58) against T. Aman (var. Swarna)-Fallow-Boro (var. BRRI dhan28), CP2= Jute (var. O-795)-T.Aman (var. Binadhan-17)-Potato (var. BARI Alu-46) instead of T.Aman (var. Swarna)-Potato (var. Lal Pakri)-Boro (var. BRRI dhan28) and CP3= T.Aman (var. BRRI dhan49)-Potato (var. BARI Alu-46)-Maize (var. BHM-9) instead of T.Aman (var. Swarna)-Potato (var. Lal Pakri)-Boro (var. BRRI dhan28). The CP1 and CP2 were used for Dasiarchhara, where the CP1 and CP3 were used for Dahalakhagrabari and Banskata.

Cropping pattern-wise initial and post experimentation soil was collected and analyzed accordingly from the three previous enclaves. The status of pre and post soil were more or less similar. Soil test based integrated plant nutrition system (IPNS) was tested against recommended dose for AEZ-3 (FRG'12) and farmers practice (FP)fertilizer dose.

Yield and yield attributes of different crops under different cropping patterns differed significantly among the treatments. Almost all crops yields were relatively higher in improved cropping pattern with IPNS treatment (T_1) followed by improved cropping pattern with recommended fertilizer (T_2). In CP1, the rice equivalent yield (REY) of T_1 was 109%, 103% and 95% higher than T_3(CP with local varieties and imbalance fertilizer use) in Dasiarchhara, Dahalakhagrabari and Banskata, respectively. In CP2, the REY of T_1 was 74% higher than T_3 in Dasiarchhara. In CP3, the REY of T_1 was 72 and 70% higher than T_3 in Dahalakhagrabari and Banskata, respectively.

In case of economic performance, the T_1 performed better than other treatments in all cropping patterns. In case of CP1, the gross margin (GM) of T_1 was 164, 153 and 133% higher compared to T_3 in Dasiarchhara, Dahalakhagrabari and Banskata, respectively, where the BCR for T_1, T_2 and T_3 were 1.99, 1.78 and 1.28 in Dasiarchhara, 1.93, 1.81 and 1.27 in Dahalakhagrabari and 1.78, 1.71 and 1.25 In Banskata, respectively. In case of CP2, the gross margin (GM) of T_1 was 134% higher compared to T_3 in Dasiarchhara, where the BCR for T_1, T_2 and T_3 were 1.63, 1.51 and 1.25, respectively in Dasiarchhara. In case of CP3, the gross margin (GM) of T_1 was 74 and72% higher compared to T_3 in Dahalakhagrabari and Banskata, respectively, where the BCR for T_1, T_2 and T_3 were 1.51, 1.48 and 1.38 in Dahalakhagrabari and 1.34, 1.27and 1.23 in Banskata, respectively. From the experimentation, it was revealed that balanced fertilization (IPNS) and inclusion of NARIs developed improved crops varieties in cropping patterns may increase the crop productivity and farmers' income.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. **Title of the CRG sub-project:** Productivity Enhancement through Adaptation of Improved Crop Production Technologies in Previous Enclaves of Northern Region of Bangladesh
2. **Implementing organization:** Bangladesh Agricultural Research Institute
3. **Name and full address with phone, cell and E-mail of PI/Co-PI (s):**
   PI: Dr. Md. Samim Hossain Molla, Senior Scientific Officer, On-Farm Research Division, Bangladesh Agricultural Research Institute, Alamnagar, Rangpur, Cell phone : +8801716595677
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4. **Sub-project budget (Tk):**
   4.1 Total: Tk.20,80,000 (Twenty Lac and eighty thousand Taka only)
   4.2 Revised (if any): Tk. 20,21,394 (Twenty lac, twenty one thousand, three hundred and ninety four Taka only)
5. **Duration of the sub-project:**
   5.1 Start date (based on LoA signed): 09 May, 2017
   5.2 End date: 30 September 2018
6. **Justification of undertaking the sub-project:** Chhitmohal or Chhit is now a historical but inauspicious name to the previous enclaves' people. Being detached from the mainland, thousands of innocent inhabitants perhaps had been among the most deprived people in the world (Rabbani, 2006). However, after 68 years, the agreement between Bangladesh and India was ratified on 6 June 2015 and Bangladesh received 111 Indian occupied enclaves (Anonymous, 2015; WIKIPEDIA, 2016) and among them about 6785 ha of 87 enclaves are under Kurigram, Lalmonirhat, Nilphamary and Panchagarh districts (DAE, 2016).Food insecurity was one of the chronic dimensions in the overwhelming enclave previous economy and it was due to totally excluded from development activities of both government and non-government organizations. Moreover, the previous enclaves' population was engaged only in subsistence farming with low agricultural productivity and restricted access to inputs technology (Rabbani, 2006). Recent on spot visit by the scientists of OFRD, BARI and open discussion with the previous enclaves' farmers exhibited that knowledge gap and unavailability of modern technologies are the major hindrance against crop productivity. In contrary the National Agricultural Research Institutions (NARIs) have been developed a number of improved technologies, which might be the good options for crop productivity enhancement and therefore,the sub-project activities were undertaken in those areas.
7. **Sub-project goal:** Attaining food security of previous enclaves' farmers through adaptation of NARIs developed technologies.
8. **Sub-project objective (s):**
   a)To find out the alternative crops and cropping patterns by assessing and comparing the existing cropping systems with NARIs technologies;
   b) To improve crop productivity through adaptation of selected NARIs developed location specific technologies (crops, cropping patterns and fertilization methods), and

c) To increase income of previous enclave farmers.

9. **Implementing location (s):**Dasiarchhara of Kurigram district; Banskata of Lalmonirhat district and Dahalakhagrabari of Panchagarh district.

10. **Methodology in brief:**

The project activities were conductedfollowing participatory approach in the farmers' field at three previous enclaves of three northern districts i.e. Dasiarchhara of Kurigram district; Banskata of Lalmonirhat district and Dahalakhagrabari of Panchagarh district. A total of 36 trial farmers of which 12 farmers (6 for CP1, 6 for CP2 or CP3 and 1 for varietal trial from the same farmer) from each location having at least 0.13 ha of cultivable land suitable for the pre-selected and existing cropping patterns (CPs) were selected for the field trial.

Baseline survey: The baseline survey was conducted on 02-12 October 2017. Farm accounting data of 105 farm households were collected from the above mentioned 3 previous enclaves for baseline survey under the project. At first, a list of all farm households from the represented villages was prepared and then 35 farm households of the villages were selected using random sampling technique. Primary data were collected from the respondents (growers and intermediaries) using pre-design interview schedules. Before going on an actual interview, a brief introduction of the aims and objectives of the study were provided to each of the respondents. The questions were asked systematically in a very simple manner and information were recorded on the interview schedules in order to minimize errors. Data were collected in the local unit and were converted into standards units (MT).After collection of the data, each interview schedule was verified for the sake of consistency and completeness. Editing was done before putting the data on the computer. Summarization, careful scrutiny and necessary summary tables have been made from the data. Tabular techniques have been used for analysis, interpretation, and presentation of data to fulfill the objectives of the baseline survey.

Varietal trial: On-farm varietal trial with mustard and potato varieties were conducted at three previous enclaves separately (one farmer per crop per location). The varietal trials with mustard were conducted during rabi season of 2017-18 to evaluate the yield performance of BARI released short duration and high yielding mustard varieties and to popularize and disseminate them in the farmer's field. The experiment was conducted following RCBD with three replications in a farmer field. Unit plot size was 80 m^2. The tested mustard varieties were BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17. Across the location, the crops were sown on 18-24 November 2017 and harvested on 12-19 February 2018.

The varietal trials with potato were conducted during rabi season of 2017-18 to evaluate the yield performance of BARI released potato varieties and to popularize and disseminate them in the farmer's field. The experiment was conducted following RCBD with three replication. Unit plot size was 40 m^2. The tested potato varieties were BARI Alu-25, BARI Alu-46 and BARI Alu-53. Across the location, potatoes were planted on 25-30 November, 2017 and harvested on 20-28 February, 2018.

Cropping pattern based trial: On the basis of partial baseline survey, three promising alternative/improved cropping patterns were selected i.e. CP1= T. Aman rice (var. BRRI dhan49)-Mustard (var. BARI Sarisha-14)-Boro rice (var. BRRI dhan58) against T. Aman rice (var. Swarna)-Fallow-Boro rice (var. BRRI dhan28), CP2= Jute (var. O-795)-T. Aman rice (var. Binadhan-17)-Potato (var. BARI Alu-46) instead of Jute (var. Moharastra) -T. Aman rice (var. Swarna)-Potato (var. Lal Pakri) and CP3= T. Aman rice (var. BRRI dhan49)-Potato (var. BARI Alu-46)- Maize (var. BHM-9) instead of T. Aman rice (var. Swarna)-Potato (var. Lal Pakri)-Boro rice (var. BRRI dhan28). The CP1 and CP2 had been selected for Dasiarchhara area, where the CP1 and CP3 had been selected for

Dahalakhagrabari and Banskata areas on the basis of farmers' choice. All the selected alternative/improved cropping patterns were evaluated under soil test based (STB) integrated plant nutrition system (IPNS) and recommended fertilizer dose (FRG'12) against farmers practice dose in existing patterns. Initial soil samples (0-15 cm depth) were collected from each farmer, and location and cropping pattern-wise composite soil samples were analyzed accordingly from the three previous enclaves (Tables 1-6) to calculate the fertilizer dose for IPNS treatment. After completion of one cycle of a cropping pattern, post soil samples (0-15 cm depth) were collected treatment wise from all cropping patterns of different locations and analyzed accordingly, and finally, treatment-wise average results of different cropping patternsof the three previous enclaves are shown inTables 16a-18b.

CP1:

Dasiarchhara:The initial soil status of the experimental field was strongly acidic with medium organic matter (Table 1). The status of total N was very low, phosphorus was medium, Sulphur was optimum, where potassium, magnesium, zinc and boron were low.

The seedling of T. Aman rice (var. BRRI dhan49 in improved pattern and var. Swarna in existing pattern) was transplanted on 03 August, 2017and harvested on 05-08 November, 2017. The fertilizers for T. Aman rice were applied in T_1 (STB base IPNS) 90-11.2-55.8-14-0-1.5-0 kg ha^{-1}, in T_2 (Rec. dose) 90-10-30-12-0-1-0 kg ha^{-1} and in T3 (farmers practice) 115.2-2.5-12.5-4-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. After harvesting of T. Aman, mustard (BARI Sarisha-14 in improved pattern and fallow in existing pattern) seed was sown on 18 November, 2017 and harvested on 11-12 February, 2018. The fertilizers for mustard were applied in T_1 (STB base IPNS) 90-12.3-42.4-3.8-2.6-1.2-1.0 kg ha^{-1}, in T_2 (Rec. dose) 90-27-32-15-3-2-1 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. Farmers practice (FP) were fallow. Liming was done with dolomite @ 1 t ha^{-1} and it needs to apply at every 4 years interval. The rice seedling of Boro rice (var. BRRI dhan58 in improved cropping pattern and var. BRRI dhan28 in existing pattern) was transplanted on 14-16February, 2018 and harvested during16-21 May, 2018. The fertilizers for Boro rice were applied in T_1 (STB base IPNS) 150-10.91-70.03-4.54-0-1.56-0 kg ha^{-1}, in T_2 (Rec. dose) 150-12-55-18-0-2.6-0 kg ha^{-1} and in T3 (farmers practice) 206.95-4.49-14.97-4.04-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively.

Dahalakhagrabari:The initial soil status of the experimental field was slightly acidic with low organic matter (Table 3). The status of total N was very low, phosphorus was very high, potassium was medium, where sulphur, magnesium, zinc and boron status were low.

The T. Aman rice seedling (var. BRRI dhan49 in improved pattern and var. Swarna in existing pattern) was transplanted during15-19 July, 2017 and harvested on 01-05 November, 2017. The fertilizers were applied in T_1 (STB base IPNS) 90-7-22.4-10.9-0-1.0-0 kg ha^{-1} in T_2 (Rec. dose) 90-10-35-12-0-1.5-0 kg ha^{-1} and in T3 (farmers practice) 58.6-17.9-44.9-6.0-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively.

After harvesting of T. Aman, mustard (BARI Sarisha-14 in improved cropping pattern and fallow in existing pattern) seed was sown on 25-27 November, 2017 and harvested on 19-28 February, 2018. The fertilizers for mustard were applied in T_1 (STB base IPNS) 90-19-22.4-13.7-2.6-1.2-1.0 kg ha^{-1} in T_2 (Rec. dose) 90-27-32-15-3-2-1 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. Farmers practice (FP) were fallow. Liming was done with dolomite @ 1 t ha^{-1} and it needs to apply at every 4 years interval. The Boro rice seedling (var. BRRI dhan58 in improved pattern and var. BRRI dhan28 in existing pattern) was transplanted during20-22 February, 2018 and harvested on 05-20 May, 2018. The fertilizers for Boro rice were applied in T_1 (STB base IPNS) 150-12-37.0-16.4-0-1.8-0 kg ha^{-1}, in T_2 (Rec. dose) 150-12-55-18-0-2.6-0 kg ha^{-1} and in T3 (farmers practice) 91.1-14.8-49.4-8.9-0-0-0 kg ha^{-}

[1]N, P, K, S, Mg, Zn and B, respectively. The hail storm on 10 May, 2018 slightly damaged the Boro rice of 1 farmer's plot.

Banskata: The initial soil status of the experimental field was strongly acidic with medium organic matter (Table 5). The status of total N, Sulphur and zinc were very low, phosphorus was very high where potassium, magnesium and boron status were low.

Seeds of T. Aman rice seed (var. BRRI dhan49 in improved and var. Swarna in existing crpping pattern) was transplanted on 13-15 July, 2017 and harvested on 05-13 November, 2017. The fertilizers were applied in T_1 (STB base IPNS) 90-7-46.9-13.4-0-1.4-0 kg ha^{-1} in T_2 (Rec. dose) 90-10-35-12-0-1.5-0 kg ha^{-1} and in T3 (farmers practice) 60.3-16.8-42-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. The crop Boro is at maturity stage. After harvesting of T. Aman, mustard (BARI Sarisha-14 in improved pattern and fallow in existing cropping pattern) seed was sown on 25-27 November, 2017 and harvested on 19-27 February, 2018. The fertilizers for mustard were applied in T_1 (STB base IPNS) 90-19-46.9-16.7-2.6-2-1.0 kg ha^{-1} in T_2 (Rec. dose) 90-27-32-15-3-2-1 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. Farmers practice (FP) were fallow. Liming was done with dolomite @ 1 t ha^{-1} and it needs to apply at every 4 years interval. The seedling of Boro rice (var. BRRI dhan58 in improved pattern and var. BRRI dhan28 in existing pattern) was transplanted on 26-28 February, 2018 and harvested on 12-21 May, 2018. The fertilizers for Boro rice were applied in T_1 (STB base IPNS) 150-12-77.4-20.1-0-2.6-0 kg ha^{-1}, in T_2 (Rec. dose) 150-12-55-18-0-2.6-0 kg ha^{-1} and in T3 (farmers practice) 110.2-20.3-39.3-10.1-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively.

<u>CP2:</u>

Dasiarchhara:The initial soil status of the experimental field was slightly acidic with low organic matter (Table 2). The status of total N, Sulphur and zinc were very low, where phosphorus, potassium, magnesium and boron status were low.

The jute seed [var. O-795 in improved cropping pattern (treated with fungicide) and var. Moharastra in existing pattern] was broadcasted on May, 2017. The fertilizers were applied in T_1 (STB base IPNS) 111-11.2-69.7-31.5-0, 4.1 and 0 kg and in T_2 (Rec. dose) 111-10-32-13-0-0-0 kg N, P, K, S, Mg, Zn and B, respectively, whereas in T_3 (farmers practice) only 17.28 kg N ha^{-1} was used. The crop jute was harvested on 24-27 July, 2017.

The seedling of T. Aman rice (var. Binadhan-17 in improved pattern and var. Swarna in existing pattern) was transplanted on 03 August, 2017 and harvested during10-11 November, 2017. The fertilizers for T. Aman rice were applied in T_1 (STB base IPNS) 90-11.2-55.8-14.0-0-1.5-0 kg ha^{-1} in T_2 (Rec. dose) 90-10-30-12-0-1-0 kg ha^{-1} and in T3 (farmers practice) 115.2-2.5-12.5-4-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. The flash flood during late August, 2017 inundated the Aman rice for 3-5 days.

The potato seed [var. BARI Alu-46 in improved pattern (treated with fungicide) and var. Lalpakri in existing pattern] was planted during25-27 November, 2017 and harvested during17-20 February, 2018. The fertilizers were applied in T_1 (STB base IPNS) 135-22.3-125.5-17.5-5.2-5.1-1.0 and 5000 kg and in T_2 (Rec. dose) 135-30-90-15-5-2-1-5000 kg N, P, K, S, Mg, Zn, B and cowdung, respectively, whereas in T_3 (farmers practice) 115.2-25-87.5-18.0-0-0-0-0 kg N, P, K, S, Mg, Zn, B and cowdung, respectively were used. Liming was done with dolomite @ 1 t ha^{-1} and it needs to apply at every 4 years interval.

CP3:

Dahalakhagrabari: The initialsoil status of the experimental field was strongly acidic with medium organic matter (Table 4). The status of total N was very low, phosphorus was very high, Sulphur and potassium was medium where magnesium, zinc and boron status were low.

The seedling of T. Aman rice (var. BRRI dhan49 in improved pattern and var. Swarna in existing pattern) was transplanted during15-18 July, 2017 and harvested during08-12 November, 2017. The fertilizers were applied in T_1 (STB base IPNS) 90-7-24.7-6.7-0-1.0-0 kg ha^{-1} in T_2 (Rec. dose) 90-10-30-12-0-1-0 kg ha^{-1} and in T3 (farmers practice) 58.6-18.0-45.0-6.6-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively.

Seeds ofpotato [var. BARI Alu-46 in improved cropping pattern (treated with fungicide) and var. Lalpakri in existing pattern] was planted during02-04 December, 2017 and harvested during26-28 February, 2018. The fertilizers were applied in T_1 (STB base IPNS) 135-21-55.5- 8.3-5.2-3.3-1.0 and 5000 kg and in T_2 (Rec. dose) 135-30-90-15-5-2-1-5000 kg N, P, K, S, Mg, Zn, B and cowdung, respectively, whereas in T_3 (farmers practice) 82.8-18.0-33.7-6.7-0-0-0-0 kg N, P, K, S, Mg, Zn, B and cowdung, respectively were used. Liming was done with dolomite @ 1 t ha^{-1} and it needs to apply at every 4 years interval.

Seeds ofMaize (var. BARI Hybrid Bhutta-9) was sown during07-10 March, 2018 and harvested during25-29 June, 2018. The fertilizers were applied in T_1 (STB base IPNS) 255-75-49.3-30.1-10.2-2.6-1.4kg ha^{-1} in T_2 (Rec. dose) 255-75-80-52-10-3-1.5 kg ha^{-1} and in T3 (farmers practice) 159.4-49.4-49.4-22.2-5.2-2.7-1.3kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. The hail storm on 10 May, 2018 slightly damaged the Maize of 2 farmer's plot.

Banskata: The initialsoil status of the experimental field was strongly acidic with medium organic matter (Table 6). The status of total N, potassium, magnesium, zinc and boron were low, phosphorus was very high and Sulphur was very low.

The seedling of T. Aman rice (var. BRRI dhan49 in improved cropping pattern and var. Swarna in existing pattern) was transplanted during13-15 July, 2017 and harvested during05-13 November, 2017. The fertilizers were applied in T_1 (STB base IPNS) 83.7-7-46.9-13.0-0-1.0-0 kg ha^{-1} in T_2 (Rec. dose) 90-10-30-12-0-1-0 kg ha^{-1} and in T_3 (farmers practice) 60.3-16.8-42-0-0-0 kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively.

Seeds ofpotato seed [var. BARI Alu-46 in improved cropping pattern (treated with fungicide) and var. Lalpakri in existing pattern] was planted during02-04 December, 2017 and harvested during25-28 February, 2018. The fertilizers were applied in T_1 (STB base IPNS) 125.5-21-105.5- 16.2-5.2-3.1-1.0 and 5000 kg and in T_2 (Rec. dose) 135-30-90-15-5-2-1-5000 kg N, P, K, S, Mg, Zn, B and cowdung, respectively, whereas in T_3 (farmers practice) 91.1-19.8-37.1-6.0-0-0-0-0 kg N, P, K, S, Mg, Zn, B and cowdung, respectively were used. Liming was done with dolomite @ 1 t ha^{-1} and it needs to apply at every 4 years interval.

Seeds ofMaize seed (var. BARI Hybrid Bhutta-9) was sown during26-28 February, 2018 and harvested during19-25 June, 2018. The fertilizers were applied in T_1 (STB base IPNS) 237-75-93.8-58.3-10.2-2.1-1.3kg ha^{-1} in T_2 (Rec. dose) 255-75-80-52-10-3-1.5 kg ha^{-1} and in T3 (farmers practice) 180.0-50.1-30.5-25.3-7.8-3.5-1.3kg ha^{-1} N, P, K, S, Mg, Zn and B, respectively. The hail storm on 10 May, 2018 slightly damaged the Maize of 2 farmer's plot.

Initial soil status of experimental plots of different previous enclaves:

Location: Dasiarchhara, Kurigram

Table1: Initial soil status under T. Aman-Mustard-Boro cropping pattern at Dasiarchhara

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
Value	5.48	1.8	0.09	13.85	24.33	0.81	0.16	0.17	0.74
Interpretation	Strong Acidic	M	VL	M	O	L	L	L	L

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

Table 2: Initial soil status under Jute-T. Aman-Potato cropping pattern at Dasiarchhara

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
Value	6	1.76	0.09	9.28	3.74	0.42	0.17	0.11	0.74
Interpretation	Slightly Acidic	L	VL	L	VL	VL	L	L	L

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

Location: Dahalakhagrabari, Panchagarh

Table 3: Initial soil status under T. Aman-Mustard-Boro cropping pattern at Dahalakhagrabari

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
Value	5.58	1.7	0.09	72.36	9.54	0.72	0.17	0.26	0.74
Interpretation	Slightly Acidic	L	VL	VH	L	L	L	M	L

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

Table 4: Initial soil status under T. Aman-Potato-Maize cropping pattern at Dahalakhagrabari

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
Value	4.87	1.8	0.09	49.88	17.54	0.76	0.16	0.25	0.74
Interpretation	Strong Acidic	M	VL	VH	M	L	L	M	L

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

Location: Banskata, Lalmonirhat

Table 5: Initial soil status under T. Aman-Mustard-Boro cropping pattern at Banskata

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
Value	5.28	1.84	0.09	61.25	4.94	0.45	0.17	0.15	0.74
Interpretation	Strong Acidic	M	VL	VH	VL	VL	L	L	L

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

Table 6: Initial soil status under T. Aman-Potato-Maize cropping pattern at Banskata

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
Value	5.23	2.21	0.11	54.89	5.69	0.87	0.18	0.15	0.74
Interpretation	Strongly Acidic	M	L	VH	VL	L	L	L	L

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

Farmer's training on related crops, cropping pattern and fertilizer management were conducted separately in three previous enclaves. Two field day and one TV media program were conducted to show the results and disseminate the output to otherfarmers. Regular monitoring and data collection of different crops were done according to the set protocols. Collected data were analyzed statistically using MS Excell, Statistix and 'R' software package (R Core Team, 2017).

11. Results and discussion:

Baseline survey:

The major outputs of baseline survey are given below-

Socio-economic outline

In general farmer's age, education, household size, farm size, etc., are traced for socio-economic outline. They are very much related with farming systems. In most of the cases, farming activities depends on farmer's age, education, size of household and size of farm

Age of the sample Farmers

There is however little variation in the age of households of the three previous enclaves of the farmer. In case of farming, age and literacy have important impact on decision making processes. The younger farmers are more technically efficient than the older farmers and a younger farmer can easily adopt new technology and thereby increase his efficiency. The average age of the farmers of Dasiarchhara, Dahalakhagrabari and Banskata are 41, 39 and 44 years, respectively (Table 7a).

Educational Status of the farmers

Level of education of the sample farmers has been divided into three groups, illiterate, primary level and secondary level(Table 7a). In the three previous enclaves, most of the farmers are illiterate due to totally absent of school, college, and other education facility (before marge with Bangladesh). On an average, in the three previous enclaves, among three levels, the highest percentage of the farmers was in illiterate level (53%) whereas lowest in secondary school level (11%). In the Dasiarchhara, 40% sample farmers were found to be illiterate, 48% sample farmers were in primary school level and 12% sample farmers were in secondary school level. In the Dahalakhagrabari, 76% sample farmers were found to be illiterate, 20% sample farmers were in primary school level and 4% sample farmers were in secondary school level. In the Banskata, 42% sample farmers were found to be illiterate, 40% sample farmers were in primary school level and 18% sample farmers were in secondary school level. Though there were no education facilities in previous condition, few farmersof previous enclaves went to outside of enclaves (Bangladesh area) and got admission in school by hiding their original identity or showing false identity with the help of Bangladeshi peoples.

Table 7(a). Average age and educational level of sample farmers at previous enclaves of Northern Region of Bangladesh

Upazila	Farmers age (year)	Educational level (%)				
		Illiterate	Primary level	Secondary level	Above Secondary level	Total literate
Dasiarchhara	41	40	48	12	0	60
Dahalakhagrabari	39	76	20	4	0	24
Banskata	44	42	40	18	0	58
All	**41**	**53**	**36**	**11**	**0**	**47**

Family Composition and effective family labor

Out of the sample farmers of the three previous enclaves, family size was higher in Dahalakhagrabari followed by Dasiarchhara and Banskata, respectively (Table 7b). On thecontrary, effective family labor was higher in Dasiarchhara followed by Dahalakhagrabari and Banskata, respectively.

Table 7(b). Average family size and effective family labor of the sample farmers at previous enclaves of Northern Region of Bangladesh

Upazila	Family size (no.)			Effective family labor (%)		
	Male	Female	Total	Male	Female	Total
Dasiarchhara	2.90	3.10	6.00	28	25	53
Dahalakhagrabari	3.11	3.05	6.16	30	21	51
Banskata	2.89	2.80	5.69	25	22	47
All	**3.05**	**2.95**	**6.0**	**24.4**	**18.6**	**43**

Land Ownership Pattern of different Farm Categories

In the three previous enclaves, three types of land holding systems were observed. Those were (i) Rented in and rented out land holding system (ii) leased in and leased out land holding system (iii) mortgage in and mortgage out land holding system. In the 1st system, land holder provides one-third of their produces to the owner of the land. In the 2nd system, land holder cultivates a land providing a certain amount of money (non-returnable) to the owner of the land. In the 3rd system, land holder cultivates a land providing a certain amount of money (returnable) to the owner of the land. The formula for computing farm size is own cultivated land + rented in land + leased in land + mortgage in the land – rented out land–leased out land– mortgage in land + homestead land + orchard + pond + fallow land. Own cultivated land of the sample farmers of Dasiarchhara, Dahalakhagrabari, and Banskata was 0.45, 0.14 and 0.30 ha, respectively whereas total cultivated land (farm size) of the three previous enclaves were 0.64 ha, 0.35 ha and 0.39 ha, respectively (Table 7c).

Table 7(c). Land ownership pattern of the sample farmers at previous enclaves of Northern Region of Bangladesh

Upazila	Own cultivated land (ha)	Rented/Leased/ Mortgaged in (ha)	Rented/Leased/ Mortgaged out (ha)	Homestead area (ha)	Orchard (ha)	Pond (ha)	Fallow land (ha)	Farm size (ha)
Dasiarchhara	0.45	0.15	0.06	0.05	0.03	0.02	0.01	0.64
Dahalakhagrabari	0.14	0.17	0.03	0.05	0.01	0.00	0.01	0.35
Banskata	0.30	0.05	0.04	0.04	0.01	0.02	0.01	0.39

Farm size = Own land + all in land – all out land

Soil Textureof the Sample Farmers

There are three soil textureavailable in the study area and in most of the Upazila, the highest amounts of land exist under the loamy soil (60.3%) followed by sandy loam soil (30%) and clay loam soil (9.7) (Table 7d). This indicates that there is scope for crop diversification. The survey results weremore or less similar to the findings of SRDI (2010).

Table 7(d). Soil textureof the sample farmers at previous enclaves of Northern Region of Bangladesh

Upazila	Soil type		
	Sandy Loam	**Loam**	**Clay Loam**
Dasiarchhara	34	61	5
Dahalakhagrabari	41	55	4
Banskata	15	65	20
All	30	60.33	9.67

Source: Field survey (2013)

Irrigation Status of the sample farmers

Irrigation status of the sample farmers in the three previous enclaves of Northern Region have been presentedin the Table 7e. Irrigation facility is available in the previous enclaves. Farmers usually use shallow tube well to irrigate their land.

Table 7(e). Irrigation status of the sample farmers at previous enclaves of Northern Region of Bangladesh

Upazila	**Area (%)**		
	Irrigated	**Non-irrigated**	**Total**
Dasiarchhara	100	0	100
Dahalakhagrabari	100	0	100
Banskata	100	0	100

Major Cropping Patterns

Cropping patterns differ on lands types, soil texture, farm category (marginal, small, medium and large) and AEZ due to climate, soil and farmers attention of crop production. At Dasiarchhara, Kurigram, the dominant cropping pattern wasT. Aman –Fallow –Boro and this cropping pattern covered about 58% of thenet cropped area (Table 7f). At Dholakhagrabari, Panchagarh, the dominant cropping pattern wasT. Aman –Fallow –Groundnut and this pattern covered about 42% of the total cultivated land (Table 7g). Again, at Banskata, Lalmonirhat, the dominant cropping pattern wasT. Aman –Fallow –Maize and this cropping pattern covered about 66% of the net cropped area (Table 7h)

Table 7(f). Area coverage under major cropping patterns practiced by the sample farmers at Dasiarchhara (previous enclaves), Kurigram

Sl.No	**Cropping Pattern**	**Percent of net cropped area**
1.	T. Aman –Fallow –Boro	58
2.	T. Aman –Fallow –Jute	17
3	Potato –Jute –T. Aman	12
4.	Wheat –Jute –T. Aman	5
5.	Potato –Boro rice –T. Aman	4
	Other	4

Table 7(g). Area coverage under major cropping patterns practiced by the sample farmers at Dahalakhagrabari (previous enclaves), Panchagarh

Sl.No	Cropping Pattern	Percent of net cropped area
1.	T. Aman –Fallow –Groundnut	42
2.	T. Aman –Fallow –Boro	27
3	Potato – Groundnut –T. Aman	16
4.	Wheat –Jute –T. Aman	4
5.	T. Aman –Chilli - Fallow	4
6	Vegetable –Vegetable -Vegetable	2
	Other	5

Table 7(h). Area coverage undermajor cropping patterns practiced by the sample farmers at Banskata (previous enclaves), Lalmonirhat

Sl.No	Cropping Pattern	Percent of net cropped area
1.	T. Aman –Fallow -Maize	66
2.	T. Aman –Fallow –Boro	23
3	T. Aman -Potato –Maize	5
4.	Vegetable –Vegetable -Vegetable	1
5.	Other	5

Variety wise information

In the previous enclaves,Indian varieties (Mainly Guty Swarna, Mamun, Swarna, Lal Swarna, Onjona, etc) were foundin T. Aman.. In Boro season hybrid rice varieties (Heera2, Jagoron, Bijoy, etc) were common but some farmers used BRRI released varieties (BRRI dhan28). At Banskata, Lalmonirhat, the farmers of the enclaves produce maize as a most

important crop in the rabi season. All the farmer's used commercial hybrid maize varieties (981, Elite, Kaberi, etc). In all the previous enclaves, farmers used Indian jute varieties(Moharastro). Most of the farmers use local varieties for groundnut,potato, and chilli (Table 7i).

Table 7(i). Used varieties of cultivated crops bythe sample farmers at previous enclaves of Northern Region of Bangladesh

	Variety		
Crop	Dasiarchhara	Dahalakhagrabari	Banskata
T. Aman rice	Swarna, Guti, Mamun	Swarna, Guti, Lal, Onjona	Swarna, Guti
Boro rice	Heera (hybrid), BRRI dhan28	Hybrid	Heera (hybrid)
Maize	-	-	Hybrid, 981, Kaberi
Jute	Indian variety	Indian variety (Moharastro)	
Potato	Local variety, Cardinal, Lalpakri	Local variety, Lalpakri, Cadinal	Local variety, Cardinal, lalpakri
Groundnut	-	Local variety	-
Wheat	Local variety, Satabdi, Prodip	Local variety, Prodip	-
Chilli	-	Local variety	-
Vegetable	-	Local variety	Local variety

Use of Input

Labor, Seed, Fertilizers and Manures (Urea, TSP, MP, Zn, Boron, Gypsum, Cowdung), Pesticide, Irrigation, tillage are the main inputs for crop production. In the three previous enclaves, T. Aman, Boro, wheat, maize, groundnut and potato are the main cultivated crops. The highest input cost was for potato cultivation followed by groundnut, Boro, jute and wheat (Table 7j, 7k and 7l).

Table 7(j). Average per hectare input use in the cultivated crops at Dasiarchhara, Kurigram

Name of crops	Input use											Tillage cost (Tk ha^{-1})	Total input cost (Tk ha^{-1})
	Human labor (m-d)	Seed (kg)	Urea (kg)	TSP (kg)	MP (kg)	Zinc sulphate (kg)	Boric acid (kg)	Gypsum (kg)	Cow dung (Tk)	Pesticide (Tk.)	Irrigation (Tk.)		
T. Aman rice	112	52	135	60	37	1.48	5.48	30	0	1140	0	5984	42247
Boro rice	135	60	180	112	112	2.18	5.48	30	0	1236	11220	7480	63479
Wheat	120	187	157	90	120	1.48	4.48	37	2244	0	3740	6732	59261
Jute	150	7.5	127	0	0	0.00	0.00	0	0	1496	0	3740	52161
Potato	142	1728	239	120	180	3.48	5.48	45	5984	3740	2992	8976	105934

Table 7(k). Average per hectare input use in the cultivated crops atDahalakhagrabari, Panchagarh

Name of crops	Input use											Tillage cost (Tk ha^{-1})	Total input cost (Tk ha^{-1})
	Human labor (m-d)	Seed (kg)	Urea (kg)	TSP (kg)	MP (kg)	Zinc sulphate (kg)	Boric acid (kg)	Gypsum (kg)	Cow dung (Tk)	Pesticide (Tk.)	Irrigation (Tk.)		
T. Aman rice	127	45	120	37	37	0	0	0	0	1608	0	6732	44304
Boro rice	135	52	224	120	82	7.48	0	0	2431	1750	15895	6732	69818
Wheat	97	150	135	67	67	0.374	0	0	0	0	5042	7106	47352
Jute	157	7	75	37	37	0	0	0	0	2431	3964	6732	56100
Potato	142	1758	187	209	232	5.61	1.87	37.4	4862	3254	4825	7106	103910
Groundnut	180	112	0	75	75	0	7.48	0	1571	3807	4077	6732	73409
Chilli	150	12342	150	75	75	14.96	7.48	37.4	3942	9649	5012	7480	81921

Table 7(l). Average per hectare input use in the cultivated crops at Banskata, Lalmonirhat

Name of crops	Input use											Tillage cost (Tk ha^{-1})	Total input cost (Tk ha^{-1})
	Human labor (m-d)	Seed (kg)	Urea (kg)	TSP (kg)	MP (kg)	Zinc sulphate (kg)	Boric acid (kg)	Gypsum (kg)	Cow dung (Tk)	Pesticide (Tk.)	Irrigation (Tk.)		
T. Aman rice	105	37	75	75	37	0	0	0	0	1309	0	7480	39158
Boro rice	112	45	105	97	90	4	0	0	1683	785	15334	7480	59847
Maize	135	19	75	112	82	7	6	67	2431	935	2618	7480	61177
Potato	120	1571	150	187	194	0	2	30	1578	2611	1870	8228	85132

Cost and Return of Different Crops

Total cost, gross return, gross margin and BCR have been presentedin the Tables7m, 7n and 7o. In the three previous enclaves, out of the major eight crops (T. Aman, boro, maize, potato, groundnut, wheat, Chilli and jute), gross margin was the highest in chilli cultivation followed by ground, maize, potato, jute, T. Aman, wheat and boro rice, respectively.

Table 7(m). Cost and return (Tk. ha^{-1}) of different crops of sample farmers at Dasiarchhara, Kurigram

Items	T. Aman	Boro	Wheat	Jute	Potato
Labor	28125	33750	30000	42500	35625
Ploughing	5984	7480	6732	3740	8976
Seed	2100	2400	9375	1875	38312
Manure	0	0	2244	0	5984
Fertilizer	4898	7393	7170	2550	10305
Pesticides	1140	1236	0	1496	3740
Irrigation	0	11220	3740	0	2992
Interest on op. capital	1479	2222	2074	1826	3708
Total variable cost	42247	63479	59261	52161	105934
Total cost	43726	65701	61335	53987	109642
Yield (t ha^{-1})	3.31	5.05	3.13	2.16	16.84
By product	5000	4000	3000	10000	0
Gross return	54650	73438	73425	74800	147350
Gross margin	10924	7737	12089	20813	37708
BCR	1.25	1.12	1.20	1.39	1.34

Table7(n). Cost and return (Tk. ha^{-1}) of different crops of sample farmers at Dahalakhagrabari, Panchagarh

Items	T. Aman	Boro	Wheat	Jute	Potato	Groundnut	chilli
Labor	30518	32314	23338	37699	34109	43085	35904
Ploughing	6732	6732	7106	6732	7106	6732	7480
Seed	1795	2094	6732	2431	36914	10210	12342
Manure	0	2431	0	0	4862	1571	3942
Fertilizer	3650	8602	5135	2842	12841	3927	7592
Pesticides	1608	1750	0	2431	3254	3807	9649
Irrigation	0	15895	5042	3964	4825	4077	5012
Interest on op. capital	1550	2705	1657	1963	3636	2569	3076
Total variable	44304	69818	47352	56100	103910	73409	81921
Total cost	45854	72523	49009	58063	107546	75978	84997
Yield (t ha^{-1})	3.54	5.18	2.73	2.11	17.44	2.4	14.7
By product	4360	3560	2340	7660	0	0	0
Gross return	57460	81260	63765	70960	130800	115200	200949
Gross margin	11606	8737	14756	12897	23254	39222	115952
BCR	1.25	1.12	1.30	1.22	1.22	1.52	2.36

Table 7(o). Cost and return (Tk. ha^{-1}) of different crops of sample farmers at Banskata, Lalmonirhat

Items	T. Aman	Boro	Maize	Potato
Labor	25133	26928	32314	28723
Ploughing	7480	7480	7480	8228
Seed	1496	1795	8602	31416
Manure	0	1683	2431	1578
Fertilizer	3740	5842	6797	10706
Pesticides	1309	785	935	2611
Irrigation	0	15334	2618	1870
Interest on op. capital	1371	2095	2141	2980
Total variable cost	39158	59847	61177	85132
Total cost	40528	61942	63318	88111
Yield (t ha^{-1})	3.71	5.29	8.40	17.53
By product	3350	2710	0	0
Gross return	55290	74125	115500	140240
Gross margin	14762	12183	52182	52129
BCR	1.36	1.20	1.82	1.59

Major Marketing Channel

Major marketing channel followed by the sampled farmers of the five previous enclaves have been shown in Table 7p. In case of rice, jute, maize, groundnut, chilli, potato and wheat, most of the farmers used the 1st and 2nd channel. Again, in case of vegetables, most of the sample farmers used the 3rd channel.

Table 7(p). Major marketing channel followed by the sampled farmers of different previous enclaves of Northern Region of Bangladesh

Upazila	Marketing Channels
Dasiarchhara, Kurigram	Farmers- Faria – Bepari –Aratdar/Mill- Retailer -Consumer Farmers- Bepari – Wholesaler - Retailer –Consumer Farmers- Retailer –Consumer
Dahalakhagrabari, Panchagarh	Farmers- Faria – Bepari –Aratdar/Mill- Retailer -Consumer Farmers- Bepari – Wholesaler - Retailer –Consumer Farmers- Retailer –Consumer
Banskata, Lalmonirhat	Farmers- Faria – Bepari –Aratdar/Mill- Retailer -Consumer Farmers- Bepari – Wholesaler - Retailer –Consumer Farmers- Retailer –Consumer

Constraints

Farmers were asked about the constraintsand they answered more than 7 constraints. These summarized and showed in Table 7q. High irrigation cost for Boro rice production was the main problem of the farmer of Dahalakhagrabari, Panchagarh. Again, lack of knowledge about new crop variety/technology, lack of quality seeds, high price of labor, lack of credit facility, lack of education were the major problem of the farmer of the three previous enclaves.

Table 7(q). Constraint to sample farmers of different previous enclaves of Northern Bangladesh

Problems	Previous enclaves of Northern Region		
	Dasiarchhara	Dahalakhagrabari	Banskata
High irrigation cost for Boro rice production	63	100	54
Lack of knowledge about new crop variety/technology	89	94	91
Low yield of crops	83	74	77
Infestation of insect& disease	71	66	63
Lack of quality seeds	83	86	89
Lack of cash money	57	60	57
High price of labor	91	89	94
Lack of credit facility	83	86	89
Lack of education	89	86	89

Varietal trial:

Mustard: Among the mustard varieties, significant variation was observed in case of seed and stover yield. Individual site-wise results showed that among the varieties, seed yield was slightly higher in BARI Sarisha-17 at Dasiarchhara (1.33 t ha^{-1}) but at others location BARI Sarisha-14 gave relatively higher seed and stover yield followed by BARI Sarisha-15 (Table 8). However, the three locations average gross return (120177 Tk. ha^{-1}) and gross margin (84525 Tk. ha^{-1}) was obtained from BARI Sarisha-14 (Table 8).

Potato: Tuber yield of potato was varied significantly in different location (Table 9). Individual site-wise results showed that among the varieties,BARI Alu-46 was produced higher tuber yield in all locations followed by BARI Alu-53. The tuber yield was lower in BARI Alu-25. Though the tuber yield was higher in BARI Alu-46, but the gross return and gross margin were lower than other varieties due to low market price, because farmers of that location choose red skin potato varieties.

Table 8: Yield performance of mustard varieties at different locations in 2017-18

Treatment	Dasiarchhara		Dahalakhagrabari		Banskata		Mean		Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
	Seed (t ha^{-1})	Stover (t ha^{-1})	Seed (t ha^{-1})	Stover (t ha^{-1})	Seed (t ha^{-1})	Stover (t ha^{-1})	Seed (t ha^{-1})	Stover (t ha^{-1})			
T_1	1.26	1.18	1.62	1.56	1.57	1.78	1.48	1.51	120177	35652	84525
T_2	1.20	1.22	1.43	1.49	1.55	1.62	1.39	1.44	112907	35652	77255
T_3	1.33	1.29	1.31	1.38	1.36	1.53	1.33	1.40	108067	35652	72415
CV (%)	9.21	11.26	10.24	11.56	8.21	9.68	-	-	-	-	-
$LSD_{0.05}$	0.11	0.10	0.15	0.21	0.20	0.22	-	-	-	-	-

Note: T_1= BARI Sarisha-14; T_2= BARI Sarisha-15; T_3= BARI Sarisha-17.
Market price: Seed= 80 Tk kg^{-1}; Stover= 1 Tk kg^{-1}

Table 9: Yield performance of potato varieties at different locations in 2017-18

Treatment	Dasiarchhara	Dahalakhagrabari	Banskata	Mean	Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
	Tuber yield (t ha^{-1})	Tuber yield (t ha^{-1})	Tuber yield (t ha^{-1})	Tuber yield (t ha^{-1})			
T_1	24.9	20.30	22.91	22.70	272440	147680	124760
T_2	27.96	37.82	29.19	31.66	253253	147680	105573
T_3	23.7	32.15	27.98	27.94	279433	147680	131753
CV (%)	12.01	8.22	9.78	-	-	-	-
$LSD_{0.05}$	4.21	5.43	4.14	-	-	-	-

Note: T_1= BARI Alu-25; T_2= BARI Alu-46; T_3= BARI Alu-53.
Market price of tuber: BAR Alu-25= 12 Tk kg^{-1}; BAR Alu-46= 8 Tk kg^{-1}; BAR Alu-53= 10 Tk kg^{-1}

Cropping pattern based trial:

CP1:

Improved CP1= T. Aman rice (BRRI dhan49)-Mustard (BARI Sarisha-14)-Boro rice (BRRI dhan58)
Existing CP1= T. Aman rice (Swarna)-Fallow-Boro rice (BRRI dhan28)

Dasiarchhara: Higher grain yield (5.02 t ha^{-1}) of T. Aman rice was produced in STB base IPNS treatment followed by recommended fertilizer in improved CP (4.92 t ha^{-1}), where Existing CP + FP dose produced the lowest rice grain yield (3.20 t ha^{-1}) (Table 10a). Higher number of grains per panicle (143) and relatively more single grain weight were contributed more for higher grain yield of improved CP under STB base IPNS treatment. In case of mustard, BARI Sharisa-14 produced higher seed yield (1.17 t ha^{-1}) in improved CPwith STB base IPNS, whereas lands remain fallow in existing CP under FPat that period (Table 10b). Maximum number of siliquas per plant (97) and seed per siliqua(25.67) enhanced seed yield of mustard in improved CP under STB base IPNS treatment. In case of Boro, higher grain yield (7.04 t ha^{-1}) was obtained from STB base IPNS treatment followed by recommended fertilizer in improved CP (6.78 t ha^{-1}), where Existing CP + FP dose produced the lowest rice grain yield (6.28 t ha^{-1})(Table 10c). Maximum number of grains per panicle (184.93) was mostly contributed for higher grain yield of improved CP under STB base IPNS treatment.

The highest rice equivalent yield of whole cropping pattern was obtained from improved CP with STB base IPNS treatment (19.88 t ha^{-1}) where existing CP with FP dose gave the lowest REY (9.51 t ha^{-1}). Higher gross return (328067 Tk. ha^{-1}), gross margin (212304 Tk. ha^{-1}) and BCR (1.99) were obtained from improved CP with STB base IPNS treatment, where existing CP with FP dose gave the lowest valuein all cases (Table 10d).

Dahalakhagrabari: The T. Aman rice grain was produced higher (5.07 t ha^{-1}) in STB base IPNS treatment followed by recommended fertilizer in improved CP (4.59 t ha^{-1}), where Existing CP + FP dose produced lowest rice grain yield (4.28 t ha^{-1}) (Table 11a). Maximum number of grains per panicle (170.49) and 1000-grain weight (22.20) were contributed more for higher grain yield of improved CP under STB base IPNS treatment. In case of mustard, higher seed yield (1.62 t ha^{-1}) was obtained from improved CPwith STB base IPNS, whereas lands remain fallow in FP based existing CPat that period (Table 11b). Maximum number of siliqua per plant (97.90) and seed per siliqua (36.59) enhanced seed yield of mustard in improved CP under STB base IPNS treatment. In case of Boro, higher grain yield (6.08 t ha^{-1}) was obtained from recommended fertilizer in improved CP followed by STB base IPNS treatment (5.98 t ha^{-1}), where Existing CP + FP dose produced the lowest rice grain yield (5.01 t ha^{-1}) (Table 11c). Maximum weight of 1000-grain weight (23.65) was mostly contributed for higher grain yield in improved CP under recommended fertilizer treatment.

The highest rice equivalent yield of whole cropping pattern was obtained from improved CP with STB base IPNS treatment (19.18 t ha^{-1}), which was identical with improved CP with rec. fertilizer treatment (18.73 t ha^{-1}). Theexisting CP with FP dose gave the lowest REY (9.47 t ha^{-1}). Higher gross return (316430 Tk. ha^{-1}), gross margin (200775 Tk. ha^{-1}) and BCR (1.93) were obtained from improved CP with STB base IPNS treatment, where existing CP with FP dose gave the lowest value in all cases (Table 11d).

Banskata: Higher grain yield (4.26 t ha^{-1}) of T. Aman rice was produced in STB base IPNS treatment followed by recommended fertilizer in improved CP (4.12 t ha^{-1}), where Existing CP + FP dose produced the lowest rice grain yield (3.78 t ha^{-1}) (Table 12a). Higher number of grains per panicle (145.21) wasmostly contributed for higher grain yield of improved CP under STB base IPNS treatment. In case of mustard, BARI Sharisa-14 produced higher seed yield (1.47 t ha^{-1}) in improved

CPwith STB base IPNS, whereas lands remain fallow in existing CP under FPat that period (Table 12b). Maximum number of siliquas per plant and seed per siliqua enhanced seed yield of mustard in improved CP under STB base IPNS treatment. In case of Boro, higher grain yield (6.13 t ha^{-1}) was obtained from STB base IPNS treatment followed by recommended fertilizer in improved CP (5.99 t ha^{-1}), where Existing CP + FP dose produced the lowest rice grain yield (5.02 t ha^{-1}) (Table 12c).

The highest rice equivalent yield of whole cropping pattern was obtained from improved CP with STB base IPNS treatment (18.21 t ha^{-1}), which was identical with improved CP with rec. fertilizer treatment (17.72 t ha^{-1}). The existing CP with FP dose gave the lowest REY (9.33 t ha^{-1}). Higher gross return (300423 Tk. ha^{-1}), gross margin (180269 Tk. ha^{-1}) and BCR (1.78) were obtained from improved CP with STB base IPNS treatment, where the lowest value in all cases was observed in existing CP with FP dose (Table 12d).

CP2:

Improved CP2= Jute (O-795) -T. Aman rice (Binadhan-17)-Potato (BARI Alu-46)

Existing CP2=Jute (Moharastra)-T. Aman rice (Swarna)-Potato (Lal Pakri)

Dasiarchhara: In case of jute, yield and yield contributing characters are presented in Table 13a. Farmers generally maintained relatively lower plant populations and besides of this severe stem rot and die back disease lowered plant populations in farmers practice (FP) plot (29.96 plant m^{-2}) than recommended plots populations (40.53 plant m^{-2}). Higher plant height (334.17 cm) and plant base perimeter (5.01 cm) were measured in T_1 (improved CP + STB based IPNS dose) than T3 (farmers practiced plot with FP dose). Significantly higher fibre (3.24 t ha^{-1}) and stick (6.79 t ha^{-1}) yield were obtained from T_1 treatment than T_3 treatment (fibre yield 2.52 and stick yield 5.27 t ha^{-1}). The grain yield of T. Aman rice was obtained higher in STB base IPNS treatment (5.31 t ha^{-1}) followed by recommended fertilizer (4.76 t ha^{-1}) in improved CP, where Existing CP + FP dose produced the lowest rice grain yield (2.90 t ha^{-1}) (Table 13b). Tuber yield of potato was differed significantly among the treatments, where T_1 (improved CP + STB based IPNS dose) produced maximum tuber yield (31.75 t ha^{-1}) followed by recommended fertilizer (28.72 t ha^{-1}) in improved CP, where Existing CP + FP dose produced the lowest tuber yield (9.64 t ha^{-1}) (Table 13c).

The highest rice equivalent yield of whole cropping pattern was obtained from improved CP with STB base IPNS treatment (31.86 t ha^{-1}). The existing CP with FP dose gave the lowest REY (9.33 t ha^{-1}).Higher gross return (525758 Tk. ha^{-1}), gross margin (258651 Tk. ha^{-1}) and BCR (1.63) were obtained from improved CP with STB based IPNS treatment, where the lowest value in all cases was observed in existing CP with FP dose (Table 13d).

CP3:

Improved CP3= T. Aman rice (BRRI dhan49)-Potato (BARI Alu-46)-Maize (BHM-9)

Existing CP3= T. Aman rice (Swarna)-Potato (Lal Pakri)-Boro rice (BRRI dhan28)

Dahalakhagrabari: The T. Aman rice grain yield was higher (4.78 t ha^{-1}) in STB based IPNS treatment followed by recommended fertilizer (4.47 t ha^{-1}) in improved CP, where Existing CP + FP dose produced lowest rice grain yield (3.89 t ha^{-1}) (Table 14a). Maximum number of grains per panicle (197.07) was contributed more for higher grain yield of improved CP under STB based IPNS treatment. In case of potato, BARI Alu-46 produced 31.92 t ha^{-1} of tuber yield in Improved CPwith STB based IPNS followed by Improved CP + Rec. fertilizer dose, whereas Existing CP + FP dose produced the lowest tuber yield (9.19 t ha^{-1}) (Table 14b). In case of maize, higher grain yield (9.45 t ha^{-1}) was obtained from STB based IPNS treatment, it was contributed by maximum grain per

cob(691.33) and 1000-grain weight (352.17 g) in this treatment (Table 14c). In farmers practice, it was produced boro rice instead of maize, where grain yield of boro rice was obtained 5.85 t ha^{-1}.

The highest rice equivalent yield of whole cropping pattern was obtained from improved CP with STB base IPNS treatment (29.19 t ha^{-1}), which was identical with improved CP with rec. fertilizer treatment (27.92 t ha^{-1}). The existing CP with FP dose gave the lowest REY (16.97 t ha^{-1}). Maximum gross return (481628 Tk. ha^{-1}), gross margin (217088 Tk. ha^{-1}) and BCR (1.51) were obtained from improved CP with STB based IPNS treatment, where the lowest value in all cases was observed in existing CP with FP dose (Table 14d).

Banskata: Grain yield of T. Aman rice (4.46 t ha^{-1}) was higher in STB based IPNS treatment followed by recommended fertilizer (4.42 t ha^{-1}) in improved CP, where Existing CP + FP dose produced lowest rice grain yield (3.10 t ha^{-1}) (Table 15a). Maximum number of grains per panicle (151.21) enhanced the grain yield in STB based IPNS treatment. In case of potato, BARI Alu-46 produced 24.95 t ha^{-1} of tuber yield in improved CPwith STB based IPNS treatment followed by Improved CP + Rec. fertilizer dose (22.10 t ha^{-1}), whereas Existing CP + FP dose produced the lowest tuber yield (7.96 t ha^{-1}) (Table 15b). In case of maize, higher grain yield (9.78 t ha^{-1}) was obtained from STB based IPNS treatment, it was contributed by maximum grain per cob (683.12) and 1000-grain weight (347.42 g) in this treatment (Table 15c). In farmers practice, it was produced boro rice instead of maize, where grain yield of boro rice was obtained 5.75 t ha^{-1}.

The highest rice equivalent yield of whole cropping pattern was obtained from improved CP with STB base IPNS treatment (25.74 t ha^{-1}). The existing CP with FP dose gave the lowest REY (15.16 t ha^{-1}). Maximum gross return (424765 Tk. ha^{-1}), gross margin (162240 Tk. ha^{-1}) and BCR (1.34) were obtained from improved CP with STB based IPNS treatment, where the lowest value in all cases was observed in existing CP with FP dose (Table 15d).

Post soil status:

After completion of one cycle of a cropping pattern, treatment-wise post soil was collected from all cropping pattern experiments of all locations and analyzed accordingly. The post soil status have been presented in Table 16a, 16b, 16c, 17, 18a and 18b. It was found that the overall soil status is more or less same as pre-soil status (Table 1, 2, 3, 4, 5 and 6). However, the nutrient status was found slightly lower in farmers practice plot than other treatments in few cases but very negligible and it might be due to imbalance fertilization.

Table 10(a): Yield and yield attributes of T. Aman under T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2017

Treatment	Plant height (cm)	Panicle $hill^{-1}$ (no.)	Grain $panicle^{-1}$ (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	107	11.80	143	23.00	5.02	5.54
T_2= Improved CP + Rec. fertilizer dose	106	11.40	135	22.50	4.92	5.43
T_3= Existing CP + FP dose	108	10.00	86	22.60	3.20	3.58
CV (%)	12.3	10.45	9.68	5.23	6.28	8.45
$LSD_{0.05}$	NS	NS	40.3	NS	1.12	1.83

CP= Cropping pattern; Improved CP= T. Aman rice (var. BRRI dhan49)-Mustard (var. BARI Sarisha-14)-Boro (var. BRRI dhan58); Existing CP= T. Aman rice (var. Swarna)-Fallow-Boro (var. BRRI dhan28); STB= Soil test base; IPNS= Integrated plant nutrition system; Rec. dose= Recommended fertilizer dose for AEZ-3 as FRG'2012; FP dose= farmers practiced fertilizer dose.

Table 10(b): Yield and yield attributes of Mustard under T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2017-18

Treatment	Plant height (cm)	Plant pop^{n} (no. m^{-2})	Siliqua plant^{-1} (no.)	Seed siliqua^{-1} (no.)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	107.80	72.32	97.00	25.67	1.49	1.17
T_2= Improved CP + Rec. fertilizer dose	105.33	70.19	81.00	23.83	1.30	1.12
T_3= Existing CP + FP dose	-	-	-	-	-	-
CV (%)	-	-	-	-	-	-
$LSD_{0.05}$	-	-	-	-	-	-

Table 10(c): Yield and yield attributes of Boro rice under T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2018

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	103.80	12.30	184.93	23.87	6.91	7.04
T_2= Improved CP + Rec. fertilizer dose	102.63	11.37	164.47	23.50	6.44	6.78
T_3= Existing CP + FP dose	104.80	10.27	152.90	21.67	5.80	6.28
CV (%)	11.42	12.14	9.85	6.44	8.34	9.32
$LSD_{0.05}$	NS	NS	25.31	NS	1.02	0.71

Table 10(d): Rice equivalent yield, cost and return of T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2017-18

Treatment	Rice equivalent yield (t ha^{-1})				Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
	T. Aman	Mustard	Boro	Total				
T_1= Improved CP + STB based IPNS	5.36	7.30	7.23	19.88	328067	115763	212304	1.99
T_2= Improved CP + Rec. fertilizer dose	5.25	6.37	6.75	18.37	303160	121881	181279	1.78
T_3= Existing CP + FP dose	3.42	0.00	6.09	9.51	156910	76590	80320	1.28
CV (%)	7.37	-	8.83	8.10	-	-	-	-
$LSD_{0.05}$	1.48	-	0.87	1.17	-	-	-	-

Table 11(a): Yield and yield attributes of T. Aman under T. Aman-Mustard-Boro (CP1) cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2017

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	115	13.82	170	22.20	4.63	5.07
T_2= Improved CP + Rec. fertilizer dose	114.0	13.68	176	23.88	4.20	4.59
T_3= Existing CP + FP dose	134.3	12.59	160	20.15	3.93	4.28
CV (%)	11.3	8.25	7.85	4.56	7.14	8.58
$LSD_{0.05}$	NS	NS	7.6	0.95	0.25	NS

Table 11(b): Yield and yield attributes of Mustard under T. Aman-Mustard-Boro (CP1) cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2017

Treatment	Plant height (cm)	Plant pop^{n} (no. m^{-2})	Siliqua plant^{-1} (no.)	Seed siliqua^{-1} (no.)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	104.97	79.33	97.90	36.59	1.62	1.65
T_2= Improved CP + Rec. fertilizer dose	101.93	73.50	80.70	36.27	1.60	1.61
T_3= Existing CP + FP dose	-	-	-	-	-	-
CV (%)	-	-	-	-	-	-
$LSD_{0.05}$	-	-	-	-	-	-

Table 11(c): Yield and yield attributes of Boro rice under T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2018

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	102	15.00	156	23.65	5.98	6.54
T_2= Improved CP + Rec. fertilizer dose	101	15.11	153	23.58	6.08	6.72
T_3= Existing CP + FP dose	103	14.72	145	22.59	5.01	5.73
CV (%)	11.14	9.32	8.77	5.67	7.28	10.45
$LSD_{0.05}$	NS	NS	10.2	NS	1.02	NS

Table 11(d): Rice equivalent yield, cost and return of T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2017-18

Treatment	Rice equivalent yield (t ha^{-1})				Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
	T. Aman	Mustard	Boro	Total				
T_1= Improved CP + STB based IPNS	4.94	7.95	6.29	19.18	316430	115655	200775	1.93
T_2= Improved CP + Rec. fertilizer dose	4.48	7.86	6.40	18.73	309020	121881	187139	1.81
T_3= Existing CP + FP dose	4.19	0.00	5.28	9.47	156268	76825	79443	1.27
CV (%)	7.86	0.00	8.87	8.36	-	-	-	-
$LSD_{0.05}$	0.25	0.00	1.02	0.64	-	-	-	-

Table 12(a): Yield and yield attributes of T. Aman under T. Aman-Mustard-Boro (CP1) cropping pattern as affected by different fertilizer doses at Banskata, Lalmonirhat in 2017

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	112	14.50	145	22.50	4.26	4.71
T_2= Improved CP + Rec. fertilizer dose	113	14.17	140	22.35	4.12	4.59
T_3= Existing CP + FP dose	116	14.50	99	21.12	3.78	4.23
CV (%)	9.21	8.72	7.56	5.68	7.28	12.34
$LSD_{0.05}$	NS	NS	20.1	NS	0.30	NS

Table 12(b): Yield and yield attributes of Mustard under T. Aman-Mustard-Boro (CP1) cropping pattern as affected by different fertilizer doses at Banskata, Lalmonirhat in 2017

Treatment	Plant height (cm)	Plant pop^{n} (no. m^{-2})	Siliqua plant^{-1} (no.)	Seed siliqua^{-1} (no.)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	96.00	101.83	37.17	34.00	1.47	1.52
T_2= Improved CP + Rec. fertilizer dose	93.33	105.67	35.83	33.33	1.43	1.49
T_3= Existing CP + FP dose	-	-	-	-	-	-
CV (%)	-	-	-	-	-	-
$LSD_{0.05}$	-	-	-	-	-	-

Table 12(c): Yield and yield attributes of Boro rice under T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Banskata, Lalmonirhat in 2018

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	107.33	12.33	154.83	23.20	6.13	6.69
T_2= Improved CP + Rec. fertilizer dose	107.42	11.67	149.50	22.59	5.99	6.55
T_3= Existing CP + FP dose	104.17	11.00	142.83	22.48	5.02	5.74
CV (%)	12.31	9.43	9.68	4.24	9.21	12.45
$LSD_{0.05}$	NS	NS	NS	NS	1.01	NS

Table 12(d): Rice equivalent yield, cost and return of T. Aman-Mustard-Boro (CP-1) cropping pattern as affected by different fertilizer doses at Banskata, Lalmonirhat in 2017-18

Treatment	Rice equivalent yield (t ha^{-1})				Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
	T. Aman	Mustard	Boro	Total				
T_1= Improved CP + STB based IPNS	4.55	7.22	6.44	18.21	300423	120154	180269	1.78
T_2= Improved CP + Rec. fertilizer dose	4.40	7.02	6.30	17.72	292348	121881	170467	1.71
T_3= Existing CP + FP dose	4.04	0.00	5.29	9.33	153915	76700	77215	1.25
CV (%)	9.81	0.00	10.83	10.32	-	-	-	-
$LSD_{0.05}$	0.35	0.00	1.04	0.70	-	-	-	-

Table 13(a): Yield and yield attributes of jute under Jute-T. Aman-Potato (CP-2) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2017

Treatment	Plant population (no. m^{-2})	Plant height (cm)	Plant base perimeter (cm)	Fiber yield (t ha^{-1})	Stick yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	40.23	334	5.01	3.24	6.79
T_2= Improved CP + Rec. fertilizer dose	40.53	327	4.81	3.07	6.18
T_3= Existing CP + FP dose	29.96	324	4.07	2.52	5.27
CV (%)	6.49	7.4	13.55	11.55	7.91
$LSD_{0.05}$	3.08	14.4	0.80	0.44	0.38

CP= Cropping pattern; Improved CP= Jute (var. O-795) -T. Aman rice (var. Binadhan-17) Potato (var. BARI Alu-46); Existing CP= T. Aman rice (var. Swarna)-Potato (var. Lal Pakri)-Jute (var. Moharastra); STB= Soil test base; IPNS= Integrated plant nutrition system; Rec. dose= Recommended fertilizer dose for AEZ-3 as FRG'2012; FP dose= farmers practiced fertilizer dose.

Table 13(b): Yield and yield attributes of T. Aman under Jute-T. Aman-Potato (CP-2) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2017

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	95	12.87	155	22.28	5.31	5.79
T_2= Improved CP + Rec. fertilizer dose	94	11.97	149	22.01	4.76	5.26
T_3= Existing CP + FP dose	106	10.58	91.09	21.45	2.90	3.23
CV (%)	11.25	8.59	10.24	4.89	4.91	9.68
$LSD_{0.05}$	10.3	1.45	20.2	NS	0.38	1.45

Table 13(c): Yield and yield attributes of Potato under Jute-T. Aman-Potato (CP-2) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2017-18

Treatment	Plant height (cm)	Tuber hill^{-1} (no.)	Tuber wt. hill^{-1} (g)	Tuber yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	58.2	7.18	480	31.75
T_2= Improved CP + Rec. fertilizer dose	57.1	7.04	468	28.72
T_3= Existing CP + FP dose	32.6	8.11	95	9.64
CV (%)	11	11.28	8.68	8.97
$LSD_{0.05}$	21.4	NS	85.3	4.76

Table 13(d): Rice equivalent yield, cost and return of Jute-T. Aman-Potato (CP-2) cropping pattern as affected by different fertilizer doses at Dasiarchhara, Kurigram in 2017-18

Treatment	Rice equivalent yield (t ha^{-1})				Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
	Jute	T. Aman	Potato	Total				
T_1= Improved CP + STB based IPNS	9.68	6.79	15.39	31.86	525758	267107	258651	1.63
T_2= Improved CP + Rec. fertilizer dose	9.12	6.09	13.92	29.14	480780	263403	217377	1.51
T_3= Existing CP + FP dose	7.53	3.71	7.01	18.25	301138	190725	110413	1.25
CV (%)	9.73	7.30	8.97	8.67	-	-	-	-
$LSD_{0.05}$	0.41	0.92	4.76	2.03	-	-	-	-

Table 14(a): Yield and yield attributes of T. Aman under T. Aman-Potato-Maize (improved CP3) and T. Aman-Potato-Boro (existing CP3) cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2017

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	104	13.11	197	21.38	4.78	5.23
T_2= Improved CP + Rec. fertilizer dose	104	13.74	171	24.10	4.47	4.93
T_3= Existing CP + FP dose	118	11.92	162	19.85	3.89	4.26
CV (%)	8.68	7.59	8.54	4.57	8.21	7.95
$LSD_{0.05}$	10.2	1.21	32.1	1.21	0.41	NS

CP= Cropping pattern; Improved CP= T. Aman rice (var. BRRI dhan49)-Potato (var. BARI Alu-46)-Maize (var. BHM-9); Existing CP= T. Aman rice (var. Swarna)-Potato (var. Lalpakri)-Boro (var. BRRI dhan28); STB= Soil test base; IPNS= Integrated plant nutrition system; Rec. dose= Recommended fertilizer dose for AEZ-3 as FRG'2012; FP dose= farmers practiced fertilizer dose.

Table 14(b): Yield and yield attributes of Potato under T. Aman-Potato-Maize (improved CP3) and T. Aman-Potato-Boro (existing CP3) cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2017-18

Treatment	Plant height (cm)	Tuber hill^{-1} (no.)	Tuber wt. hill^{-1} (g)	Tuber yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	84.4	10.87	582	31.92
T_2= Improved CP + Rec. fertilizer dose	77.9	10.47	574	30.49
T_3= Existing CP + FP dose	52.6	12.77	161	9.19
CV (%)	11.3	12.35	10.28	9.87
$LSD_{0.05}$	20.2	NS	200	5.42

Table 14(c): Yield and yield attributes of Maize under T. Aman-Potato-Maize (improved CP3) and Boro under T. Aman-Potato-Boro (existing CP3) cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2018

Treatment	Plant height (cm)	Cob length (cm)	Cob diameter (cm)	Panicle hill^{-1} (no.)	Grain cob^{-1} or panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS (Maize)	220.14	17.50	16.33	-	691.33	352.17	9.45	12.23
T_2= Improved CP + Rec. fertilizer dose (Maize)	218.48	17.61	16.05	-	685.16	346.12	9.18	11.86
T_3= Existing CP + FP dose (Boro)	105.12	-	-	15.05	148.07	23.11	5.85	6.25

Table 14(d): Rice equivalent yield, cost and return of T. Aman-Potato-Maize (improved CP3) and T. Aman-Potato-Boro (existing CP3)cropping pattern as affected by different fertilizer doses at Dahalakhagrabari, Panchagarh in 2017-18

Treatment	Rice equivalent yield (t ha^{-1})					Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
	T. Aman	Potato	Maize	Boro	Total				
T_1= Improved CP + STB based IPNS	5.10	15.48	8.62	-	29.19	481628	264540	217088	1.51
T_2= Improved CP + Rec. fertilizer dose	4.77	14.78	8.37	-	27.92	460690	257121	203569	1.48
T_3= Existing CP + FP dose	4.15	6.68	-	6.14	16.97	280038	155320	124718	1.38
CV (%)	8.08	9.87	-	-	8.98	-	-	-	-
$LSD_{0.05}$	0.46	5.42	-	-	2.94	-	-	-	-

Table 15(a): Yield and yield attributes of T. Aman under T. Aman-Potato-Maize (improved CP3) and T. Aman-Potato-Boro (existing CP3) cropping pattern as affected by different fertilizer doses at Banskata, Lalmonirhat in 2017

Treatment	Plant height (cm)	Panicle hill^{-1} (no.)	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	108	12.67	151	22.75	4.46	4.92
T_2= Improved CP + Rec. fertilizer dose	107	13.00	148	22.35	4.42	4.79
T_3= Existing CP + FP dose	119	12.00	99	21.92	3.10	3.55
CV (%)	11.0	10.28	7.6	4.89	6.25	7.65
$LSD_{0.05}$	NS	NS	23.3	NS	0.45	1.21

Table 15(b): Yield and yield attributes of Potato under T. Aman-Potato-Maize (improved CP3) and T. Aman-Potato-Boro (existing CP3) cropping pattern as affected by different fertilizer doses at Banskata, Lalmonirhat in 2017-18

Treatment	Plant height (cm)	Tuber hill^{-1} (no.)	Tuber wt. hill^{-1} (g)	Tuber yield (t ha^{-1})
T_1= Improved CP + STB based IPNS	92.2	9.33	447.67	24.95
T_2= Improved CP + Rec. fertilizer dose	94.5	9.18	422.83	22.10
T_3= Existing CP + FP dose	46.3	11.33	188.67	7.96
CV (%)	9.0	10.24	8.58	8.23
$LSD_{0.05}$	21.3	1.25	90.36	2.12

Table 15(c): Yield and yield attributes of Maize under T. Aman-Potato-Maize (improved CP3) and Boro under T. Aman-Potato-Boro (existing CP3) cropping pattern as affected by different fertilizer doses at Banskata, Lalmonirhat in 2018

Treatment	Plant height (cm)	Cob length (cm)	Cob diameter (cm)	Panicle hill^{-1} (no.)	Grain cob^{-1} or panicle^{-1} (no.)	1000-grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1= Improved CP + STB based IPNS *(Maize)*	231.07	18.22	17.12	-	683.12	347.42	9.78	12.18
T_2= Improved CP + Rec. fertilizer dose *(Maize)*	228.21	17.86	17.03	-	679.23	344.33	9.45	11.76
T_3= Existing CP + FP dose *(Boro)*	107.05	-	-	12.07	145.22	23.05	5.75	6.40

Table 15(d): Rice equivalent yield, cost and return of T. Aman-Potato-Maize (improved CP3) and T. Aman-Potato-Boro (existing CP3) cropping pattern under different fertilizer doses at Banskata in 2017-18

Treatment	Rice equivalent yield (t ha^{-1})					Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
	T. Aman	Potato	Maize	Boro	Total				
T_1= Improved CP + STB based IPNS	4.76	12.10	8.89	-	25.74	424765	262525	162240	1.34
T_2= Improved CP + Rec. fertilizer dose	4.71	10.72	8.59	-	24.01	396218	257121	139097	1.27
T_3= Existing CP + FP dose	3.32	5.79	-	6.05	15.16	250058	155900	94158	1.23
CV (%)	6.95	8.23	-	-	7.59	-	-	-	-
$LSD_{0.05}$	0.83	2.12	-	-	1.48	-	-	-	-

Post soil status in different treatmentsunder different cropping patterns:

CP1:

Table 16(a): Post soil status under T. Aman-Mustard-Boro cropping pattern at Dasiarchhara

	pH	OM (%)	Total N (%)	P	S	Zn	B*	K	Mg
				µg/g soil				meq/100g soil	
T1	5.76	1.88	0.10	9.64	2.31	0.75	-	0.17	1.40
Interpretation	Slightly Acidic	M	L	L	VL	L		L	O
T2	5.76	1.71	0.09	9.96	5.70	0.64	-	0.15	1.41
Interpretation	Slightly Acidic	L	VL	L	VL	L		L	O
T3	5.73	1.68	0.09	9.44	5.17	0.84	-	0.16	1.53
Interpretation	Slightly Acidic	L	VL	L	VL	L		L	H

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

T_1= Improved CP + STB based IPNS, T_2= Improved CP + Rec. fertilizer dose, T_3= Existing CP + FP dose

*B analyses for post soil could not be done due to machine disturbance

Table 16(b): Post soil status under T. Aman-Mustard-Boro cropping pattern at Dahalakhagrabari

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
T1	5.69	1.83	0.09	32.27	9.31	0.95	-	0.23	0.77
Interpretation	Slightly Acidic	M	VL	VH	L	L		M	L
T2	5.76	1.60	0.08	28.94	9.81	0.54	-	0.22	0.72
Interpretation	Slightly Acidic	L	VL	VH	L	L		M	L
T3	5.63	1.64	0.08	37.91	9.41	0.49	-	0.22	0.73
Interpretation	Slightly Acidic	L	VL	VH	L	M		M	M

Table 16(c): Post soil status under T. Aman-Mustard-Boro cropping pattern at Banskata

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
T1	5.27	1.44	0.10	62.93	4.49	1.11	-	0.14	0.35
Interpretation	Strongly acidic	L	L	VH	VL	M		L	VL
T2	5.40	1.90	0.09	62.00	2.77	0.74	-	0.12	0.50
Interpretation	Strongly acidic	M	VL	VH	VL	L		L	L
T3	5.41	1.82	0.09	55.95	3.72	0.87	-	0.16	0.35
Interpretation	Strongly acidic	M	VL	VH	VL	L		L	VL

CP2:

Table 17: Post soil status under Jute-T. Aman-Potato cropping pattern at Dasiarchhara

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
T1	6.32	1.80	0.09	5.56	3.12	1.33	-	0.12	1.29
Interpretation	Slightly Acidic	M	VL	L	VL	M		L	O
T2	6.41	1.36	0.07	4.44	6.34	0.86	-	0.10	1.28
Interpretation	Slightly Acidic	L	VL	VL	VL	L		L	O
T3	6.45	1.74	0.09	5.58	2.52	1.48	-	0.13	1.61
Interpretation	Slightly Acidic	L	VL	L	VL	O		L	H

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

T_1= Improved CP + STB based IPNS, T_2= Improved CP + Rec. fertilizer dose, T_3= Existing CP + FP dose

CP3:

Table 18(a): Post soil status under T. Aman-Potato-Maize cropping pattern at Dahalakhagrabari

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
T1	6.33	1.81	0.09	43.07	6.63	0.77	-	0.16	0.43
Interpretation	Slightly Acidic	M	VL	VH	VL	L		L	L
T2	6.63	2.16	0.11	66.86	6.27	1.07	-	0.20	0.40
Interpretation	Slightly Acidic	M	L	VH	VL	M		M	L
T3	6.06	1.46	0.07	68.36	4.82	0.57	-	0.18	0.46
Interpretation	Slightly Acidic	L	VL	VH	VL	L		L	L

VL=very low, L=Low, M=Medium, O=Optimum, H=High, VH=Very high, OM=Organic Matter

T_1= Improved CP + STB based IPNS, T_2= Improved CP + Rec. fertilizer dose, T_3= Existing CP + FP dose

Table 18(b): Post soil status under T. Aman-Potato-Maize cropping pattern at Banskata

	pH	OM (%)	Total N (%)	P	S	Zn	B	K	Mg
				µg/g soil				meq/100g soil	
T1	5.41	1.49	0.08	136.64	9.09	0.74	-	0.11	0.42
Interpretation	Strongly acidic	L	VL	VH	L	L		L	L
T2	5.40	1.85	0.11	84.69	6.49	1.15	-	0.13	0.50
Interpretation	Strongly acidic	M	L	VH	VL	M		L	L
T3	5.35	1.77	0.09	74.43	12.22	1.29	-	0.13	0.41
Interpretation	Strongly acidic	M	VL	VH	L	M		L	L

12. **Research highlight/findings**:

- Among the tested varieties of mustard, BARI Sarisha-14 was found more suitable and profitable across the locations.
- Among the tested varieties of potato, BARI Alu-46 was found high yielder but BARI Alu-53 (red skin) was more profitable and preferable across the locations due to its red skin color, which had more market demand.
- Alternative CP, Mustard (var. BARI Sarisha-14)-Boro (var. BRRI dhan58)-T. Aman (var. BRRI dhan49) with STB based IPNS treatment gave 109, 103 & 95% higher REY and 164, 153 & 133% higher GM than existing cropping pattern, Fallow-Boro (var. BRRI dhan28)-T. Aman (var. Swarna) with FP at Dasiarchhara, Dahalakhagrabari& Banskata, respectively.
- Improved CP, Potato (var. BARI Alu-46)-Jute (var. O-795)-T. Aman (var. Binadhan-17) with STB based IPNS treatment produced 74% higher REY and 134% higher GM than existing cropping pattern Potato (var. Lal Pakri)-Jute (var. Maharastro)-T. Aman (var. Swarna) with FP at Dasiarchhara.
- Alternative CP, Potato (var. BARI Alu-46)-Maize (var. BHM-9)-T. Aman (var. BRRI dhan49) with STB based IPNS treatment produced 72 & 70% higher REY and 74 & 72% higher GM than existing pattern Potato (var. Lal Pakri)-Boro (var. BRRI dhan28)-T. Aman (var. Swarna) with FP at Dahalakhagrabari& Banskata, respectively.
- Profitable fertilizer package for Mustard (var. BARI Sarisha-14)-Boro (var. BRRI dhan58)-T. Aman (var. BRRI dhan49) cropping pattern:

Location	Mustard*	Boro	T. Aman
	N-P-K-S-Mg-Zn-B-Cowdung (kg ha^{-1})		
Dasiarchhara	65-4.77-30.94-3.79-2.57-1.20-0.97-5000	150-7.64-63.03-4.54-0-1.56-0-0	90-4.77-38.20-3.03-0-0.84-0-0
Dahalakhagrabari	65-11.50-10.94-13.65-2.57-1.40-0.94-5000	150-12-33.33-16.38-0-1.82-0-0	90-4.90-20.20-10.92-0-0.98-0-0
Banskata	65-11.20-35.39-16.71-2.57-2-0.94-5000	150-12-69.63-20.05-0-2.60-0-0	90-4.90-42.20-13.37-0-1.40-0-0

**1000 kg ha^{-1} lime at every 4 years interval*

- Profitable fertilizer package for Potato (var. BARI Alu-46)-Jute (var. O-795)-T. Aman (var. Binadhan-17):

Location	Potato*	Jute	T. Aman
	N-P-K-S-Mg-Zn-B-Cowdung (kg ha^{-1})		
Dasiarchhara	110-14.82-114- 17.51-5.15-5.07-0.94-5000	111-7.81-62.75-31.51-0-4.13-0-0	90-7.81-50.20-14.01-0-1.45-0-0

**1000 kg ha^{-1} lime at every 4 years interval*

- Profitable fertilizer package for Potato (var. BARI Alu-46)-Maize (var. BHM-9)-T. Aman (var. BRRI dhan49):

Location	Potato*	Maize	T. Aman

	N-P-K-S-Mg-Zn-B-Cowdung (kg ha^{-1})		
Dahalakhagrabari	110-13.50-44- 8.31-5.15-3.31-0.97-5000	255-52.50-44.40-30.14-10.15-2.63-1.36-0	90-4.90-22.20-6.70-0-0.92-0-0
Banskata	100.50-13.50-94- 16.21-5.15-3.07-0.90-5000	237.06-52.50-93.78-58.34-10.15-2.14-1.26-0	83.67-4.90-42.20-12.97-0-0.75-0-0

**1000 kg ha^{-1} lime at every 4 years interval*

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	Desktop Computer (1), Steel Almira (1), Camera (1)	109000	Desktop Computer (1), Steel Almira (1), Camera (1)	109000	100%
(b) Lab &field equipment	-	-	-	-	-
(c) Other capital items	-	-	-	-	-

2. **Establishment/renovation facilities:**Not applicable

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Not applicable					

3. Training/study tour/ seminar/workshop/conference organized:

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training (3 in 3 locations)	35	01	36	1 day	
(b) Workshop	26	4	30	1 day	
(c) Field day (2 in 2 locations)	90	70	160	1 day	

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	438960	438960	438960	0	100	-
B. Field research/lab expenses and supplies	817915	814325	814325	0	100	Lack of GoB fund
C. Operating expenses	280509	277591	277509	82	99.97	Tk. 82 not expended, remain in Bank
D. Vehicle hire and fuel, oil & maintenance	135710	130410	130410	0	100	Lack of GoB fund
E. Training/workshop/seminar etc.	149300	141390	141390	0	100	Lack of GoB fund
F. Publications and printing	75000	0	0	0	0	Fund not released
G. Miscellaneous	15000	14325	14325	0	100	Lack of GoB fund
H. Capital expenses	109000	109000	109000	0	100	-

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome(short term effect of the research)
a) To find out the alternative crops and cropping patterns by	- Baseline surveyconducted and analyzed data compared with NARIs developed technologies. - Data collected from secondary	- Location specific profitable alternative cropping pattern with suitable crops and varieties have been identified.	- Awareness has been created among the farmers to use proper crops/varieties for their cropping system.

assessing and comparing the existing cropping systems with NARIs technologies.	sources such asDAE, other NARS institutes and farmers.		
b) To improve crop productivity through adaptation of selected NARIs developed location specific technologies (crops, cropping patterns and fertilization methods)	- Implementation of on-farm trials on varietal performance, alternative cropping pattern and fertilizer packages performance against farmers practice. - Monitoring, data collection and analysis.	- IPNS based fertilizer packages have been validatedon the 3 cropping patterns for respective previous enclaves. - Across the locations, crop productivity increasedabout70-109% by adopting improved/alternative cropping patterns including modern varieties and proper fertilizer doses. - Cropping intensity has increased from 200% to 300% crops in a year in the project area by introducing alternative cropping patterns.	- Increased crop productivity can ensure food security. - Knowledge on modern agricultural technologies especially crop residue management and IPNS methods for maintaining soil health have been improved along with selection of crops varieties and management practices. - Proper land utilization and cropping intensity enhancement are possible by using improvedcropping patterns. - Farmers of the 3 locations have preserved a total of90 kg mustard seed (BARI Sarisha-14), 2400 kg potato seed (BARI Alu-53, BARI Alu-46 & BARI Alu-25), 154 kg T. Aman rice seed (Binadhan-17, BRRI dhan-49) seeds and also demanded to buy jute (O-795) seeds for next year production and continuation of the improved cropping patterns.
c) To increase farm efficiency and income of previous enclave farmers.	- Farmer training on improved crop production technologies developed by NARIs. - Participatory implementation of cropping pattern based trials using modern varieties and fertilization techniques. - Arranging Field day on developed cropping patterns. - Project findings visualized in aWorkshop.	- Farmers' income (gross margin) increased about72-164% across the locations. - Irrespective of the developed cropping patterns, the BCR were found 1.23-1.99.	- Poverty may be reduced to some extent with livelihood improvement. - Farmers' capacity have been improved on production of new cropping patternsusing new crops/varieties through modern technology based training.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ **booklet**/leaflet/flyer etc.	1	-	বাংলাদেশের উত্তরাঞ্চলের সাবেক ছিটমহল এলাকায় আলু-পাট-রোপা আমন ফসল ধারার উন্নয়ন ও ব্যবস্থাপনা
Journal publication	-	-	-
Information development	-	-	-
Other publications, if any (**Farmers Training Manual**)	-	1	কৃষক প্রশিক্ষণ ম্যানুয়াল "বাংলাদেশের উত্তরাঞ্চলের পূর্ববর্তী ছিট মহলে উন্নত ফসল উৎপাদন প্রযুক্তি অভিযোজনের মাধ্যমে উৎপাদনশীলতা বৃদ্ধি"

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

Identifiedcropping pattern and fertilizer package for the previous enclaves of northern region:

a) Cropping pattern1: Mustard (var. BARI Sarisha-14)-Boro (var. BRRI dhan58)-T. Aman (var. BRRI dhan49)

Fertilizer package:

Location	Mustard*	Boro	T. Aman
	N-P-K-S-Mg-Zn-B-Cowdung (kg ha^{-1})		
Dasiarchhara	65-4.77-30.94-3.79-2.57-1.20-0.97-5000	150-7.64-63.03-4.54-0-1.56-0-0	90-4.77-38.20-3.03-0-0.84-0-0
Dahalakhagrabari	65-11.50-10.94-13.65-2.57-1.40-0.94-5000	150-12-33.33-16.38-0-1.82-0-0	90-4.90-20.20-10.92-0-0.98-0-0
Banskata	65-11.20-35.39-16.71-2.57-2-0.94-5000	150-12-69.63-20.05-0-2.60-0-0	90-4.90-42.20-13.37-0-1.40-0-0

**1000 kg ha^{-1} lime at every 4 years interval*

b) Cropping pattern2: Potato (var. BARI Alu-46)-Jute (var. O-795)-T. Aman (var. Binadhan-17)

Fertilizer package:

Location	Potato*	Jute	T. Aman
	N-P-K-S-Mg-Zn-B-Cowdung (kg ha^{-1})		
Dasiarchhara	110-14.82-114- 17.51-5.15-5.07-0.94-5000	111-7.81-62.75-31.51-0-4.13-0-0	90-7.81-50.20-14.01-0-1.45-0-0

**1000 kg ha^{-1} lime at every 4 years interval*

c) Cropping pattern3: Potato (var. BARI Alu-46)-Maize (var. BHM-9)-T. Aman (var. BRRI dhan49)

Fertilizer package:

Location	Potato*	Maize	T. Aman
	N-P-K-S-Mg-Zn-B-Cowdung (kg ha^{-1})		
Dahalakhagrabari	110-13.50-44- 8.31-5.15-3.31-0.97-5000	255-52.50-44.40-30.14-10.15-2.63-1.36-0	90-4.90-22.20-6.70-0-0.92-0-0
Banskata	100.50-13.50-94- 16.21-5.15-3.07-0.90-5000	237.06-52.50-93.78-58.34-10.15-2.14-1.26-0	83.67-4.90-42.20-12.97-0-0.75-0-0

**1000 kg ha^{-1} lime at every 4 years interval*

ii. **Generation of new knowledge that help in developing more technology in future**

Soil test based IPNS fertilizer package was found suitable for the tested crops and it needs to develop for other crops suitable to grow in the previous enclaves.

iii. Technology transferred that help increased agricultural productivity and farmers' income

The benefit of improvedcropping pattern with soil test based IPNS fertilizer package may help to increase agricultural productivity and farmers' income in the previous enclaves.The messagewas broadcasted on TV media "Channel i" and in print media "Juger Alo".

iv. Policy Support

- All previous enclaves need to bring under intensive agricultural development program with the involvement of GO and NGOs.
- Banking facility and easy access to agricultural loan from bank are needed to improve farm activity.
- Potato production in the previous enclaves of northern Bangladesh was found promising. Cold storagefacilities to be constructed for disseminating potato in the study area.

G. Information regarding Desk Monitoring

Desk Monitoring (description & output of consultation meeting, monitoring workshops/seminars etc.):

- Duration of monitoring workshop: 15 May 2018
- Output: Result need to be given in Table rather than figure. In cropping pattern trial, detail information on crop management aspects, date of sowing and harvesting, crop duration and BCR may be given. Conclusion should be given considering cropping pattern. Very appropriate study for those farmers of Enclaves. Continuation of those studies is needed for those areas.

H. Information regarding Field Monitoring

Field Monitoring (time& No. of visit, Team visit and output):

- Duration of Field Visit: 20 March 2018
- Coverage of Monitoring Report: From May 2017 to March 2018
- Location(s) of the Program: Previous enclaves of Dasiarchhara, Kurigram, Banskata, Lalmonirhat and Dahalakhagrabari, Panchagar.
- Field Monitoring Members: 1. Md. Abdur Rahman and 2. Dipok Kumar, Monitoring Associate, PIU, BARC, Dhaka
- Output: Continuing the sub-project as per planned following standard methodology.

I. Lesson Learned/Challenges (if any)

i) Unavailability of cold storage for potato discourages the previous enclave's farmers though potato cultivation was found very promising in those areas.
ii) Lack of knowledge and quality agricultural input in all previous enclaves lowering the agricultural productivity.
iii) Lack of Institutional facility and support, the rapid development of agricultural sector is slower.

J. Challenges (if any)

Natural calamities especially hail storm was slightly affected jute crop and heavy rainfall & historical flash flood submerged T. Aman rice for two to six days and subsequently rice harvesting was delayed at Dasiar Chhara, Kurigram. Damaged road communication was also hampered monitoring partially during the flood and post-flood period. Maize at Dahala Khagrabari, Panchagarh and Banskata, Lalmonirhat was partially lodged due to storm. Banking facility and Agricultural loan system are very limited in the previous enclaves.

Signature of the Principal Investigator
Date .....
Seal

ড. মোঃ শামীম হোসেন মোল্লা
ঊর্ধ্বতন বৈজ্ঞানিক কর্মকর্তা (কৃষি তত্ত্ব)
সমেঘমিন গবেষণা বিভাগ
বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট
কৃষি গবেষণা কেন্দ্র, রংপুর।

Counter signature of the Head of the organization/authorized representative
Date .....
Seal

পরিচালক (গবেষণা)
বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট
জয়দেবপুর, গাজীপুর।

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