Integrated Farming Research and Development for Livelihood Improvement in the Plainland Ecosystem

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Sub-project Completion Report
on
Integrated Farming Research and Development for Livelihood Improvement in the Plainland Ecosystem

February 2018 to January 2022

Coordinating Organization
Planning & Evaluation Division
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Implementing Organization

On-Farm Research Division
Bangladesh Agricultural Research Institute

Rice Farming Systems Division
Bangladesh Rice Research Institute

Technology Testing and Farming Systems Division
Bangladesh Fisheries Research Institute, Mymensingh

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Abbreviation and Acronyms

BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agricultural Research Institute
BBS	:	Bangladesh Bureau of Statistics
BCRDV	:	Baby chick Ranikhet Disease Vaccine
BQ	:	Black Quarter
BRRI	:	Bangladesh Rice Research Institute
BCR	:	Benefit Cost Ratio
CP	:	Cropping Pattern
CRFSR&D	:	Climate Resilient Farming Systems Research and Development
cm	:	Centimeter
DAE	:	Department of Agricultural Extension
DAT	:	Days After Transplanting
Dec.	:	Decimal
FGD	:	Focus Group Discussion
FMD	:	Foot and Mouth Disease
FRG	:	Fertilizer Recommendation Guide
FSR	:	Farming Systems Research
FSRD	:	Farming System Research and Development
FYM	:	Farm Yard Manure
GM	:	Gross Margin
GR	:	Gross Return
ha	:	Hectare
HS	:	Hemorrhagic Septicemia
IDA	:	International Development Agency
IFAD	:	International Fund for Agricultural Development
kg	:	Kilogram
LSP	:	Local Service Provider
MBCR	:	Marginal Benefit Cost Ratio
NATP	:	National Agricultural Technology Program
OFRD	:	On-Farm Research Division
PBRG	:	Programme Based Research Grant
PCR	:	Project Completion Report
PIU	:	Project Implementation Unit
PPR	:	Peste Des Petits Ruminants
RDV	:	Ranikhet Disease Vaccine
REY	:	Rice Equivalent Yield
t/ha, t ha^{-1}	:	Tonnes per Hectare
Tk.	:	Taka
TVC	:	Total Variable Cost
WB	:	World Bank

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Executive Summary

Livelihood improvement is a very complex system and an individual's livelihood involves the capacity to acquire basic necessities in order to satisfy the basic needs. Increasing the capability of sufficient earning, security of nutritional and safe food, medical care, education, assets, acceptable life leading with social status may involve with the livelihood improvement. Integrated farming is now gaining priority to ensure food, nutrition and income security of resource poor farm households with the rapid increasing of population and declining of agricultural land. From the above views, the program was undertaken to develop integrated farming technologies, fine tune the technologies generated by NARS institutes, integrate component technologies with efficient use of farm resources and thereby improve family income and livelihoods. The integrated farming programs were initiated under the coordinated sub-project on "Integrated Farming Research and Development for Livelihood Improvement in the Plainland Eco-system" started from February 2018 at seven Farming Systems Research and Development (FSRD) Sites of BARI, BRRI and BFRI continued up to January , 2021. A total of 12 farmers from two villages comprising of four from each of marginal, small and medium farmers group considering homestead vegetables, fruits, field crops, poultry and livestock, fisheries and off-farm component of farming systems.

BARI: All components were brought under improved technological intervention and accordingly incomes were increased from these components. The average homestead size was 0.05, 0.14, 0.09, 0.13 and 0.07 ha at FSRD site Rangpur, Pabna, Faridpur, Tangail and Sherpur, respectively. In the homestead component, the average vegetables produced per homestead 624 kg after intervention (AI), which was only 167 kg before intervention (BI). The average vegetables consumption during AI was 254 g head^{-1}day^{-1}, which was 279% higher than BI. The average fruits produced per homestead 502 kg, which was only 279 kg during BI due to improper management. The average consumption of fruits was also increased (Avg. 84%) during AI due to motivational work. The daily nutritional requirements of a family members were supplemented considerably especially carotene and Vit-C due to increased consumption of vegetables and fruits from the homestead gardening. Animal product from fish, chicken, pigeon, Turkey and livestock also could help to minimize the protein deficiency. Fruit tree management was created a good impact on farm households and a total of 611 fruit trees were brought under pest management and a total of 3811 saplings of different fruits were distributed in different sites. Women participation (25-80%) in different agricultural activities increased to a great extent that showed some positive effect on gender equity within the family. The average crop land size was 0.43, 0.84, 0.64, 0.61 and 0.54 ha^{-1} in Rangpur, Pabna, Faridpur, Tangail and Sherpur area, respectively. In field crops component, two or three crops-based CP was successfully replaced by three to four crops-based CP. Among them Potato included 4 crop-based CP T. Aus-T. Aman rice-Potato/Sweet gourd and T. Aus-T. Aman-Potato-Mungbean produced higher REY 51.39 and 29.99 t ha^{-1}, respectively. In pilot production program, sole crop Tomato gave maximum gross margin (Tk. 605200 ha^{-1}) at Rangpur than other location. In the livestock component, deworming and vaccination, the frequency of major diseases of cattle e.g., Anthrax, FMD, PPR, BQ etc. were reduced to below 7% and addition of vitamin ADE injection increased the lactation period and yield remarkably. Cattle fattening and calf rearing programs were created interest among the farmer due to remarkable gain of cattle body weight (18-46%). Goat rearing was found promising because of low rearing cost and high profit with in short period. In poultry system, Sonali breed, Naked-neck (Garchila) chicken, Khaki Campbell duck, Turkey bird and Pigeon rearing in the homestead area created a good impact among the farm families as a good source of income and child nutrition. Mortality of poultry reduced (70-99%) after vaccination. Moreover, farm yard manure (FYM) production (3050 Kg homestead^{-1}) and vermicompost production (320 kg homestead^{-1}) and their utilization, and green fodder production (53 t ha^{-1}) were created a good impact among the farm families. The average pond size was 0.04-0.06 ha over the locations. Seasonal fish culture with carp polyculture in seasonal pond was found promising than monoculture of Tengra, Pabda and Shing. Carp polyculture gave a satisfactory fish production (Avg.171 kg 13 dec.$^{-1}$ size pond) and gross margin (Avg. Tk.12513 13 decimal^{-1} size pond) at farmers' level. From different types of off-farm activities (e.g., weaving Katha, sewing cloths, making handicrafts and Kumra Bora, hatching egg, grocery shop, pulling van/rickshaw etc.), farmers also earned some extra money (Avg. gross margin Tk. 5173 household^{-1}).

Among the different production components, field crop sector gave maximum gross margin (Tk. 103647 to. 250910 farm^{-1})but gross margin increased maximum at homestead vegetables production sector (54-753%), where total gross margin increased 63-277% per farm. Field days organized on homestead gardening and T. Aus rice production including four crops-based cropping patterns created a great impact in the locality. The activities (seed and seedling collection, production and distribution/sell) of Local Service Provider (LSP) were found promising for home gardening, vaccination and other activities at FSRD site, Ajoddhapur, Rangpur where about twenty-three thousand seedlings of different crops was produced and supplied or sell among the neighbor farmers by LSP.

BRRI: Crop component, improvement of the existing cropping pattern through replacement of rice variety, inclusion of rice and non-rice crops and improved management practice have been completed. Total productivity was increased about 60-70% over existing cropping pattern. Pilot production on newly released variety of Aus rice BRRI dhan48 and BRRI dhan83: Aman rice BRRI dhan71 and BRRI dhan75 and Boro rice BRRI dhan50 and BRRI dhan88 were very good in respect of yield. Farmers opined that, cultivation of modern Aus, Aman and Boro rice were good considering production and income. Vegetables production at homestead increased as well as consumption, distribution and selling of vegetables increased about 92, 19 and 85%, respectively. After managing fruit trees, consumption, distribution and selling of fruits were also increased about 47, 60 and 67%, respectively. Average cost of production per farmer per year was Tk. 1572 and average gross return from homestead vegetables production was Tk. 4882. Women specially showed interest in homestead vegetables production especially cultural operations. In livestock component, turkey rearing under scavenging system, pigeon and goat rearing increased farm income. Semi aquatic production system of vegetables, fruits and fish in the derelict pond was highly profitable and farmers are very much interested about this new technology. Other activities like drumstick plantation, utilization of fallow land under orchard, spraying of fruit trees is in progress. Fruit sapling distribution, chewing type sugarcane cultivation at homestead, Palmyra palm seed sowing etc. were also done.

BFRI: Under crop component, year round vegetables production at homestead of 24 households gave a total yield of 25.37 tons of vegetables with an average income of Tk. 3625/month/household. Vegetables production at homestead gave a total yield of 25.37 tons of vegetables with a gross margin of Tk. 3625 household^{-1} month^{-1}. The crop wise highest and lowest yields were obtained from Bottle gourd (8610 kg) and Carrot (570 kg), respectively. Under production program hybrid papaya (var. Red lady), HYV Cucumber (var. Field King), Pani Kachu (var. Latiraj), summer Tomato (BARI Hybrid Tomato-4), integrated Rice-fish Culture, HYV of Aus rice (Binadhan-19) and Ladies finger in fallow land. Hybrid Papaya (var. Red lady) produced an average yield of 750 kg household^{-1} and gave a gross income of Tk. 12500 household^{-1}. Summer Tomato cultivation with BARI Hybrid Tomato-4 gave an average yield of 360 kg farmer^{-1} with an average gross income of Tk. 18600. The yield of Aus rice (var. Binadhan-19) was found 4.76 t ha^{-1} while production cost and gross margin was Tk. 54896 and Tk. 18932 ha^{-1}, respectively. Farmers were very happy for getting straw as byproduct for their cattle. Production program of Pani kachu (var. Latiraj) yielded 27 and 22 t ha^{-1} of curd and stolon, respectively with gross margin of Tk. 40000 ha^{-1}. In fisheries component, over wintered fingerlings polyculture, the average production was 7120 kg/ha/6 months. Whereas, in Pabda and Gulsha Culture, average production was 7382 kg/ha/5 month. Shing with monosex GIFT were cultured in farmers pond. The average fish production was found 14263 kg ha^{-1} after five months rearing. The average production of Pabda and Gulsha in polyculture management showed 10372 kg/ha/6 months. Monosex GIFT Tilapia with Shing and Magur, showed average production 13735 kg ha^{-1}. While, average production was 13735 kg ha^{-1} was obtained from culture of Koi with GIFT tilapia and Silver carp in pond. The average production of Shing with Magur in pond was achieved 21003 kg ha^{-1} in six months culture period applying floating supplementary feed. In livestock component, a total of 10 mature ducks were distributed in each farmer and monthly egg production farm family^{-1} from duck was 150. The monthly average egg consumption family^{-1} was only 58 with an average income of Tk. 922 month^{-1}. Five female farmers were provided with five pairs of mature pigeons. By rearing of Pigeons a farmer averagely obtained 9 pairs of squabs which provided Tk. 3240/7 months. After de-worming, the body weight gain of treated cattle was 13% higher while in case of non-treated cattle showed only 2.38%.

Through vaccination programme, the mortality rate of the vaccinated animals reduced by 2.03% and the average milk production of lactating animals increased by 33%. A total of forty farmers (male 21 and female 19) were trained on ecofriendly production of vegetables, high valued fish production and poultry rearing in two batches under this programme. Partial integration among the farm components was found as a cost saving technology especially compost pit based integration activities were found promising.

Key words: Farming system, Farming components food security, homestead model, integrated farming, livelihood, Plain Land Ecosystem

PBRG Sub-project Completion Report (PCR)

A. Sub-project Description

1. Title of the PBRG sub-project
   Integrated Farming Research and Development for Livelihood Improvement in the Plainland Ecosystem

2. **Implementing organization**
   On-Farm Research Division (OFRD), Bangladesh Agricultural Research Institute (BARI), Gazipur
   Rice Farming Systems Division, Bangladesh Rice Research Institute (BRRI), Gazipur
   Bangladesh Fisheries Research Institute (BFRI), Mymensingh

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4. Sub-project budget (Tk.)

4.1 Total (in Tk.as approved): 3,70,00000

4.2 Latest Revised (if any): 3,48,64000

5. Duration of the sub-project:

5.1 Start date (based on LoA signed): 4 February 2018

5.2 End date: January 2022

6. Background of the sub-project

The subsistence farms of Bangladesh are highly diversified with complex relationships among the various sub-system and the enterprises within a subsystem. Subsistence farm are integrated in nature and compost of different enterprises like crop, vegetables, livestock, fisheries and they are run by holistic approaches (Rahman *et al.,* 1989). In this farming system, common resources are shared by its components and by product of one component may be used by others. In Bangladesh most of the farms are diversified and integrated, however their production potentials are not up to the mark. Resources, inputs, management and component of farming are not well selected for the environment they are existed or used and their interactions are not well planned, as a result integration is loose resulting poor system yield. While there are different production alternatives, farmers have a limited set of resources. These resources may be utilized in such a manner that maximize farm productivity, farmers benefit and resource use efficiency in an environmentally sound and sustainable way. A holistic approach to technology generation and packaging is essential to achieve this result through maximizing the complementary interactions among the different farming enterprises/ production system and the biophysical and socio-economic environment. In most cases, farmers have limited resources. Proper utilization of these resources with improved technologies can ensure higher production and income generation. Crop component plays the major role in income generation of the farmers; the role of other component cannot be ignored. Livestock, Fishery, Homestead vegetables production and Agro-forestry also substantially contributed in the earnings and livelihood of the farmers. There is a scope to bring improvement in these sub-sector. Each and every farmer had some homestead area. Poor utilization of such areas was a common feature. FSR activities helped to take adequate care of many areas through the vegetables production programmer round the year. BARI, BRRI and BFRI have developed a number of technologies which can be used for increasing production and income of the farmer. BARI, BRRI and BINA have already developed improved crop varieties and cropping pattern with management practices involving 3 or 4 crops. BLRI has also developed improved technologies on beef fattening, calf rearing, improved poultry breeds, poultry rearing and protection of livestock from major diseases. Besides BFRI has developed Polyculture of carps using over wintered fingerlings (Ahmed and Alam 1989), Culture technique of Pabda & Gulsha, Refinement of Mono sex GIFT Tilapia with Shing, Culture of Pabda & Gulsha with carp Culture of Monosex GIFT (Oreochromis niloticus) with Shing (Heteropneustes fossilis) and Magur (Clarias batrachus), Culture of Monosex GIFT (Oreochromis niloticus) with Shing (Heteropneustes fossilis) and Magur (Clarias batrachus), culture of Koi with tilapia and silver carp culture of Shing with Magur in ponds. The proven technologies of crops, cropping pattern, plantation crops, home garden & family nutrition, livestock & fish production as well as other income generating activities will be included in the new proposals. Apart from the above integrated approach, other issues that merit concern for sustainability of FSRD are: Continuation of on-farm trial & technology verification/validation to new FSRD sites; impact studies & constraints to non-adoption of technology & feedback for the station scientists. Strengthen inter-constitutional cooperation & linkage through quick participations of research, extension & development agencies. Overall, the sub-project is aimed to increase the production, income, employment opportunity, nutrition etc. and ultimately enhance livelihood status of the target farms towards poverty alleviation.

To study the interaction of the components in improving farm income and mobilization of farmers resources in appropriate direction in depth studies with holistic approach if needed. Through the holistic approach, each and every possible source of income generation can be knocked and their impact on farmer's condition can be well judged. The knowledge and experience gained through past sixteen years activities can be well exercised through the new programme of holistic approach. Therefore, research on

integrated farming system and dissemination of component technologies to increase system production and improve farmer's livelihood is necessary. BARI, BRRI and BFRI has been studying farming system research and development under the coordinated sub-project entitled "Integrated Farming Research and Development for Livelihood Improvement in the Plain Land Ecosystem" from February 2018 - January 2021.

7. Sub-project general objective

To improve livelihood of rural households through generation and adoption of Farming System Technologies.

8. Sub-project specific objectives

BARC Component:

i. To coordinate, monitor and evaluate FSRD activities of the partner institutes

ii. To establish linkage with concerned stakeholders in terms of development activities.

BARI-Component:

i. To develop integrated farming technologies to maximize farm productivity with efficient use of farm resources.

ii. To modify fine tune on station technologies generated by NARS institutes and at different FSRD sites of plain land ecosystems.

iii. To integrate component technologies (crops, livestock, fisheries, agro-forestry and homestead gardening, etc.) for improving farm productivity.

iv. To establish linkage with different stakeholders.

BRRI Component:

i. To generate climate resilient and site-specific farming system technologies by optimizing land use for the Madhupur tract of Bangladesh

ii. To fine tune and disseminate farming system technologies in the physical, biological and social environment of the extrapolation domain with efficient use of farm resources.

BFRI Component:

i. To develop location-specific system-based technologies

ii. To modify/fine tune on-station technologies generated by NARS institutes at different Agro-ecological Zones (AEZs)

iii. To integrate component technologies (crops, livestock, fisheries and homestead, etc.) for improving farm productivities

iv. To establish linkage with concerned stakeholders

v. To increase family income and livelihood status

9. Implementing locations

Implementing locations were selected based on climatic, edaphic, social, vegetation and economic conditions of the regions. Two villages were selected for each FSRD site i.e., Ajoddhapur, Rangpur; Ganggarampur, Pabna; Sholakundu, Faridpur; Atia, Delduar, Tangail and Tarakandi, Sherpur.

FSRD site Ajoddhapur, Rangpur

Two villages named South Ajoddhapur and Jhautary village under Rangpur Sadar upazila of Rangpur district were considered for FSRD activities. Ajoddhapur has a distance of sixteen km from the upazila head quarter and is located at the west side (25°40′ N latitude and 89°10′ E longitude; AEZ-3).

Map 9.1 FSRD site Ajoddhapur, Rangpur

FSRD site Ganggarampur, Pabna

In Pabna, Ganggarampur has a distance of eighteen km from the upazila head quarter and is located at the east side (24°03′ N latitude and 89°38′ E longitude; AEZ-11).

Map 9.2 FSRD site Ganggarampur, Pabna

FSRD site Sholakundu, Faridpur

The Integrated Farming Research and Development for Livelihood Improvement in the Plainland Ecosystem project site named Sholakundu, Kanaipur, Faridpur is located at 23°43' north latitude and 89°28' east longitude (AEZ-11 and 12). The site is situated about 10 km south of district head quarter. It spreads over a part of Kanaipur union under Faridpur Sadar upazila.

Map 9.3 FSRD site Sholakundu, Faridpur

FSRD site Atia, Tangail

The FSRD site Atia is situated at the two villages namely Hinganagar and Mahmudpur of Atia union under Delduar Upazila of Tangail district. It is twelve km far away from the district headquarter and is also located at the east side 24°17′ N latitude and 89°90′ E longitude. Delduar Upazila with an area of 184 sq km is bounded by Tangail Sadar and Basail upazilas on the north, Nagorpur upazila on the south, Basail and Mirzapur upazilas on the east and Nagorpur and Tangail Sadaron the west. Dholeshori river flow at the west side of this Upazila.

Map 9.4 FSRD site Atia, Tangail

FSRD site Tarakandi, Sherpur

The Tarakandi, Sherpur FSRD site is located at N 24°58′59.33″ to E 90°06′21.62″. The area is under Old Bhramaputra Floodplain (AEZ-8 and AEZ-9). Sherpur is bounded by Jamalpur district on the south and west, Mymensingh district on the east, Indian province of Meghalaya on the north. Main rivers are Brahmaputra and Vogad

Map 9.5 FSRD site Tarakandi, Sherpur

FSRD site Sreepur, Gazipur

Bangladesh Rice Research Institute (BRRI) have been selected Tengra village under Sreepur upazilla of Gazipur district for conducting Farming Systems Research and Development (FSRD) activities. The site is in Madhupur Tract, AEZ 28 consists of acid upland and slightly undulating soil.

Map 9.6 FSRD site Sreepur, Gazipur

FSRD site Mokamia, Fulpur Mymensingh

Bangladesh Fisheries Research Institute (BFRI) have been selected Mokamia village under Fulpur upazilla of Mymensingh district for conducting Farming Systems Research and Development (FSRD) activities. Mokamia is a small village of Fulpur Upazilla and about 35 Km away from the District Headquarter and about 05 Km away from the Upazilla Headquarter.

Map 9.7 FSRD site Mokamia, Fulpur Mymenshing

10. Methodology in brief

The Farming Systems Research and Development Programme (FSRDP) have been working with slightly modified methodology of the Asian Farming Systems Network, the successor of the Asian Cropping Systems Network. The modification has been made to adopt and make it more applicable to Bangladesh condition. For the successful implementation of the proposed integrated farming systems research and development program, the following methods were considered:

Specific Methodology

The integrated farming system research and development activities were executed at seven FSRD sites of BARI, BRRI and BFRI in Plainland ecosystem with the coordination of Planning and Evaluation Division, BARC during February 2018 to January 2022 for improving livelihood of rural households through generation and adoption of Farming System Technologies especially integrated farming technologies and the technologies generated by NARS institutes. The selected FSRD sites of different NARS institutes have been presented in the Table 10.1.

Table 10.1. Sub-project locations/sites

Sl. No.	Implementing organization	District	Upazila	FSRD Site
1.	OFRD, BARI, Pabna	Pabna	Pabna Sadar	Gangarampur
2.	OFRD, BARI, Rangpur	Rangpur	Rangpur Sadar	Ajoddhapur
3	OFRD, BARI, Tangail	Tangail	Delduar	Atia
4	OFRD, BARI, Sherpur	Sherpur	Sherpur Sadar	Tarakandi
5	OFRD, BARI, Faridpur	Faridpur	Faridpur Sadar	Sholakundu
6	RFSD, BRRI, Gazipur	Gazipur	Sreepur	Tengra
7	BFRI, Mymensingh	Mymensingh	Fulpur	Mokamia

For the successful implementation of the integrated farming system research and development program, some methods were considered. The considering methods were: Site selection and description, Identification and prioritization of problems, Preparation of research and development program, Discussion on the program, Selection of cooperator farmers, Program execution and recommendation domain and Follow-up evaluation. Site selection was done on the basis of climatic, edaphic, social, vegetation and economic conditions of the regions so that the site was representative. Site includes geographical location, physical, biological, social and economic conditions, infra-structural condition, existing farming systems, resource situation, general problems etc. Detailed survey, case studies, participatory rural appraisal, exploratory survey, participation in different meetings/workshops of extension organization like UECC/DTC/DECC/ATC. DAE and in different regional and central review meetings and workshops of research institutes, personal observations etc.

The program was executed in a participatory approach, where critical inputs and technological suggestions were provided by BARI, BRRI & BFRI personnel and other commodities were used from farmer's own sources. Based on farmer's traditional practices, their needs and choices, several alternatives of technologies of crops, livestock, fisheries, off-farm activities and other components were incorporated with active participation of the farmers. According to the aim of the program resource poor farmers-marginal, small and medium having major components of farming and sizeable homestead under single ownership were targeted and twelve farm households from two villages were selected at each site (Table 10.2).

Table 10.2. Category wise selected farmers information of different FSRD sites.

FSRD site	Categories	No. of Farmer	Avg. family size (no.)	Avg. crop land size (ha)	Avg. homestead area (ha)	Avg. pond area (ha)
Ajoddhapur Rangpur	Marginal	4	4.5	0.18	0.057	0.032
	Small	4	4.25	0.44	0.058	0.034
	Medium	4	5.25	0.97	0.048	0.054
Ganggarampur, Pabna	Marginal	4	5.0	0.435	0.084	0.03
	Small	4	5.75	0.891	0.126	0.04
	Medium	4	5.5	1.188	0.195	0.04
Sholakundu, Faridpur	Marginal	4	4.50	0.17	0.047	0.028
	Small	4	5.00	0.64	0.103	0.037
	Medium	4	4.25	1.12	0.11	0.06
Atia, Delduar Tangail	Marginal	4	6.5	0.19	0.11	-
	Small	4	4.66	0.58	0.13	0.05
	Medium	4	5.0	1.05	0.16	0.05
Tarakandi, Sherpur	Marginal	1	4.00	0.06	0.06	-
	Small	8	4.38	0.45	0.064	0.048
	Medium	3	5.33	1.12	0.08	0.08
Tengra. Sreepur, Gazipur	Marginal	4	4.2	0.21	0.052	-
	Small	4	4.8	0.42	0.10	0.05
	Medium	4	5.20	1.12	0.13	0.15
Mokamia. Fulpur, Mymensingh	Marginal	4	3.5	0.20	0.26	0.04
	Small	4	4.7	0.41	0.08	0.06
	Medium	4	5.8	1.01	0.12	0.10

Training program was arranged to buildup farmers capacity and to develop awareness regarding nutrition and crop production. An individual household survey (Benchmark survey) was carried out before starting the project activities. The detail information regarding livelihoods pattern were documented. Total resources inventory, liabilities, technology used, level of input used, output obtained, income and expenditure status, labor availability of the farms of previous year was accounted by detail households' case study with intensive visit and cross examinations for authentication of the data before intervention. Based on the potentials suitable technological options were addressed to the farmers and accordingly farmers selected suitable technologies adjusting with their need for livelihood improvement. Year-round vegetable production followed by respective location-wise model in each homestead, fruit tree management and new plantation, crops and cropping system improvement through improve cropping pattern development and promising variety piloting, vaccination of poultry and livestock, rearing of Turkey, poultry, pigeon and calf, green fodder production, fish culture and some off-farm activities were identified as their major potential area.

However, season-wise (Rabi= October-March, Kharif I= April-June and Kharif II= July-September) data on production, farm level utilization with disposal pattern, possible integration among the components, economic return focusing income and expenditure and other socio-economic information were collected and tabulated accordingly.

A. Homestead Production System

Twelve different categories farmers consisting of 3.5 to 6.5 members were selected on the basis of available resources. The selected farmers were provided training and suggestion by the FSRD team on year-round vegetables and quick growing fruits production following respective site wise production model.

a) Vegetables

Based on farmers' preference and agro-ecological suitability, the vegetables production models of different locations were determined and followed accordingly.

1. BARI

Table 10.3. Syedpur model (Modified) at Ajoddhapur, Rangpur

Niche/space		Year-round homestead vegetables and fruits pattern		
		Rabi (October- March)	Kharif-I (April-June)	Kharif-II (July-September)
1. Open sunny space	Bed 1	Radish	Red amaranth	Kangkong
	Bed 2	Cabbage	Stem amaranth	Merah shak
	Bed 3	Brinjal+ Spinach	Red amaranth	Indian spinach
	Bed 4	Tomato+ Napashak	Okra	Red amaranth
	Bed 5	Garlic+Leafy coriander	Leafy Jute	Okra
2. Roof		Bottle gourd	Ash gourd	Ash gourd
3. Trellis		Country bean	Sweet gourd/Snake gourd	Sweet gourd
4. Fence		Bitter gourd/country bean	Yard long bean/Ridge gourd	Bitter gourd
5. Tree support		Country bean	Potato yam/Sponge gourd	Potato yam
6. Marshy land		Water tarro (Kalakachu), Aroid (Latiraj)		
7. Backyard		Papaya, Banana, Guava, Mango, Lemon, Sugarcane, Palm, Moringa		
8.Partially shady place		Ginger, Turmeric, Moulovi kachu		
9. House boundary		Papaya, Lemon, Malta etc.		
10. Pond bank		Creeper vegetables, Papaya, Lemon, Napier grass etc.		

Table 10.4 Goyeshpur model at Ganggarampur, Pabna

Niche/space		Cropping patterns		
		Rabi	Kharif-I	Kharif-II
1. Open sunny space	Bed-1	Radish	Stem Amaranth	Indian spinach
	Bed-2	Cabbage	Brinjal	Red Amaranth
	Bed-3	Tomato	Spinach	Okra
2. Fence		Bitter gourd	Yard long bean	Bitter gourd
3. Trellis		Bottle gourd	Sweet gourd	Sweet gourd
4. Roof		Bottle gourd	Wax gourd	Wax gourd
5. Tree support		Bitter gourd	Ridge gourd	Sponge gourd
		Potato yam	Snake gourd/Potato yam	Potato yam
		Country bean	Yard long bean	Yard long bean/Country bean
6. Partial shady area		Elephant foot yam		
		Leaf aroid (moulavi kachu)		
		Turmeric		
		Perennial chilli		
7. Marshy land		Pani kachu (Latiraj)		
8. Homestead boundary		Papaya (3-5 plant)		
		Guava (1-2 plant)		
		Lemon (1-2 plant)		
9. Back yard /waste land		Drumstick (1-2 tree)		
		Banana		

Table 10.5 Ishan Gopalpur model at Sholakundu, Faridpur

Sl.no	Location		Cropping Pattern
1	Open space	a	Radish-Red Amaranth-Indian spinach
		b	Spinach-Tomato-Stem Amaranth
		c	Cabbage-Okra-Okra
		d	Cauliflower -Gimakolmi- Gimakolmi
		e	Broccoli-Red Amaranth- Stem Amaranth
		f	Potato-Indian Spinach-Indian Spinach
2	Roof top		Bottle gourd-Ash gourd
3	Trellis		Bottle gourd-Sponge gourd Bottle gourd- Sweet gourd
4	Tree support		Potato yam
5	Partial shady area		Moulavi kachu
6	Marshy Land		Tarro
7	Fence		Country bean-Ridge gourd/Country bean- Bitter gourd
8	Homestead boundary		Papaya, Guava and Lemon
9	Back Yard/ Waste land		Banana
10	Pond bank		Sweet gourd-Ash gourd/ Country bean- Ridge gourd

Table 10.6. Palima model at Atia, Tangail

Niche/space		Cropping patterns		
		Rabi	Kharif-I	Kharif-II
1. Open sunny space	Bed 1	Tomato/Radish	Okra	Indian spinach
	Bed 2	Brinjal+ Lalshak	Indian spinach	Okra+ Lalshak
	Bed 3	Spinach	Gimakalmi	Gimakalmi
	Bed 4	Bush bean	Amaranthus	Indian spinach
2. Trellis		BARI Lau-1/Local	Ash gourd	Sponge gourd
		BARI Lau-2/Local	Bitter gourd	Snake gourd
		Bottle gourd	Sweet gourd	Ash gourd
3. Roof		BARI Lau-1/Local	Ash gourd	Ash gourd
		Sweet gourd	Ash gourd	Ash gourd
4. Tree support		Potato yam	Potato yam	Potato yam
		Potato yam	Potato yam	Potato yam
		-	Sponge gourd	Sponge gourd
5. Partial shady area		Ginger	Ginger	Ginger
		Ginger	Ginger	Ginger
6. Pond bank		Napier	Napier	Napier
		Bottle gourd	Blackgram	Blackgram
		Arum	Arum	Arum
7. Slightly marshy land		Latiraj	Latiraj	Latiraj

Table 10.7. Narekeli model at Tarakandi, Sherpur

Niche/space		Cropping pattern		
		Rabi	Kharif-I	Kharif-II
1. Open sunny space	Bed 1	Tomato	Indian spinach	Danta
	Bed 2	Lalshak + Cabbage	Kangkong	
	Bed 3	Coriander + Onion	Okra	
	Bed 4	Spinach + Garlic	Chilli	
	Bed 5	Carrot + Bitter gourd	Latiraj kachu	

Niche/space	Cropping pattern		
	Rabi	Kharif–I	Kharif–II
2. Roof top	Country bean	White gourd	-
3. Trellis	Country bean, Bottle gourd	Yard long bean	-
4. Fence	Bitter gourd	-	-
5. Marshy land	Latiraj kachu		
6. Shady place	Turmeric, Ginger		
7. Boundary	Papaya, Drumstick		
8. Unused tree	Potato yam		

2. BRRI

Table 10.8. Modified Goyeshpur model at Tengra, Sreepur, Gazipur

Niche/space		Cropping patterns		
		Rabi	Kharif–I	Kharif–II
1. Open sunny space	Bed-1	Radish	Stem Amaranth	Indian spinach
	Bed-2	Cabbage	Brinjal	Red Amaranth
	Bed-3	Tomato	Spinach	Okra
2. Fence		Bitter gourd	Yard long bean	Bitter gourd
3. Trellis		Bottle gourd	Sweet gourd	Sweet gourd
4. Roof		Bottle gourd	Wax gourd	Wax gourd
5.Tree support		Bitter gourd	Ridge gourd	Sponge gourd
		Potato yam	Snake gourd/Potato yam	Potato yam
		Country bean	Yard long bean	Yard long bean/Country bean
6.Partial shady area		Elephant foot yam		
		Leaf aroid (moulavi kachu)		
		Turmeric		
		Perennial chilli		
7. Marshy land		Pani kachu (Latiraj)		
8. Homestead boundary		Papaya (3-5 plant)		
		Guava (1-2 plant)		
		Lemon (1-2 plant)		
9. Back yard /waste land		Drumstick (1-2 tree)		
		Banana		

b) Fruits

On the basis of farmers' choice, agro-ecological suitability and human nutrition requirement, the fruits saplings were supplied and plantation were done in the homestead area and nearby homestead area. In Rangpur, a sole Dragon fruit orchard and a mixed fruit garden with Mango, Guava and Litchi were established. Mixed fruit garden was also established at Pabna. Irrigation, fertilization, pest control and other management of new and existing fruit trees were undertaken in this program.

B. Crops and Cropping System

a) Improvement or development of cropping pattern

There were different types of cropping pattern exist in different locations. Among the existing cropping patterns, more prominent cropping pattern were considered for the improvment or replace by alternate profitable cropping pattern. To increase crop productivity, two to three cropping patterns were considerd for development at each FSRD site under plainland ecosystem.

Table 10.9. Activities for improvement or development of cropping pattern under plainland ecosystem.

FSRD sites	Existing cropping pattern	Date of sowing/ transplanting	Date of harvesting	Alternative improved cropping pattern	Date of sowing transplanting	Date of harvesting
Ajoddhapur, Rangpur (BARI)	T. Aman (Swarna)-Fallow-Boro (BRRI dhan28)	20-25 July - 25-28 Feb	27-30 Nov - 20-23 Jun	T Aman (Binadhan-17)-Mustard (BARI Sarisha-14)-Boro (BRRI dhan28)	5-18 Aug 27 Nov-7 Dec 25 Feb-7 Mar	11-19 Nov 22-27 Feb 28 Jun-11 Jul
	T. Aman (Swarna)-Potato (BARI Alu-8)-Boro (BRRI dhan28)	5-10 Aug 1-5 Dec 1-7 Mar	23-30 Nov 24-27 Feb 15-22 Jun	T Aus (BRRI dhan48)-T. Aman (Binadhan-17)-Potato (BARI Alu-25)-Sweet gourd (BARI Hybrid Mistikumra-1)	10-17 May 12-17 Aug 25-30 Nov 7-12 Dec. (relay)	5-10 Aug 20-23 Nov 5-9 Feb 7-14 April
Ganggarampur, Pabna (BARI)	T. Aman (BRRI dhan39)-Mustard (Tori-7) Boro (Local)	22-28 Jul 26-30 Nov 25-28 Feb	20-25 Nov 20-25 Feb 3-7 Jun	T Aman (Binadhan-17)- Mustard (BARI Sarisha-17)-Boro (BRRI dhan28)	24 July 15 Nov 20 Feb	05 Nov. 20-25 Feb. 16 May
	T. Aman (BRRI dhan39)-Lentil (BARI Masur-6)-Sesame (Local)	25-30 July 15-20 Nov 15 Mar	21-24 Nov. 15 Mar 25 Jun	T. Aman (Binadhan-17)-Lentil (BARI Masur-8)-Sesame (BARI Til-4)	30 Jul 10 Nov 9 Mar	8 Nov 20-22 Mar. 20 June
Sholakundu, Faridpur (BARI)	Lentil (Local)-Jute (JRO 524)-T. Aman (BRRI dhan39)	28 Nov to 4 Dec 26 Mar to 5 Apr 30 Jul to 15 Aug	15-20 Mar.- 20-30 Jul.- 12-30 Nov	Lentil (BARI Masur-8)-Jute (Rabi-1)-T. Aman (Binadhan-17 /BRRI dhan75)	16-30 Nov 28 Mar 7 Apr 10-15 Aug	8-24 Mar 1-8 Aug 17-20 Nov
	Mustard (Tori-7)-Jute (JRO 524)-T. Aman (BRRI dhan39)	9-20 Nov.- 25-30 Nov.- 26 Mar to 5 Apr. 20-30 Mar	27 Jan to 6 Feb /10-15 Feb- 20 Jul to 3 Aug/18-25 Jul. 5-15 Nov./ 25-30 Nov	Mustard (BARI Sarisha-17/18)-Jute (Rabi-1)-T. Aman (Binadhan-17/ BRRI dhan75)	9-20 Nov./ 25-30 Nov.- 26 Mar to 5 Apr./ 20-30 Mar.- 12-18 Aug./ 5-10 Aug	10-18 Feb/ 5-8 Mar- 28 Jul to 6 Aug/20-27 July- 15-20 Nov.
Atia, Delduar Tangail (BARI)	Boro (BRRI dhan29)- T. Aman (BR11)-Mustard (Tori-7)	6-15 Feb.- 8-14 Jul- 10-15 Nov.	13-22 Jun- 24-31 Oct- 25-30 Jan	Boro (BRRI dhan29)-T. Aman (BRRI dhan72)-Mustard (BARI Sarisha-14)	10-18 Feb.- 25-31 Jul- 12-16 Nov.	15-24 Jun.- 25-30 Oct.- 5-10 Feb.

FSRD sites	Existing cropping pattern	Date of sowing/ transplanting	Date of harvesting	Alternative improved cropping pattern	Date of sowing transplanting	Date of harvesting
Tarakandi, Sherpur (BARI)	Brinjal (Singhnath)- T. Aman (BR11)- Cabbage (Autumn queen)	20-25 Jan.- 14-25 Jul- 15-19 Nov.	10 Mar to 28 Jun- 24-29 Oct 10-20 Feb.	Okra (BARI Dherosh-2)- T. Aman (BRRI dhan72)- Cabbage (Autumn queen)	9-12 Mar. 20-25 Jul.- 10-16 Nov.	20 Apr to 25 Jun 14-20 Oct.- 7-17 Feb.
	T. Aman (Hori)- Fallow- Boro (BRRI dhan29)	27 to 29 Jul- Fallow- 25 to 26 Jan	20 to 25 Nov- Fallow- 20 to 30 May	T. Aman (BRRI dhan49)- Potato (BARI Alu-25)- Mungbean (BARI Mung-6)- T. Aus (BRRI dhan48)	18 to 29 Aug- 18 to 28 Nov- 4 to 9 Mar- 28 May to 02 Jun	10 to 15 Nov- 17 to 20 Feb- 10 to 20 May- 15 to 20 Aug
Tengra, Sreepur, Gazipue (BRRI)	T. Aman (Hori)- Fallow- Boro (BRRI dhan29)	27 to 30 Jul- Fallow- 25 to 27 Jan	24 to 26 Nov- Fallow- 25 to 29 May	T. Aus (BRRI dhan48)- T. Aman (BRRI dhan49)-Motor shuti (BARI Motor shuti-3)- Boro (Hybrid shakka)	25 to 30 May- 20 to 28 Aug- 21 to 24 Nov- 4 to 17 Feb	13 to 15 Aug- 10 to 15 Nov- 28 to 30 Jan- 14 to 20 May
	Boro (BRRI dhan28)- Fallow- T. Aman (Swarna)	5 to15 Jan Fallow 30 to 31 Aug	11 to17 May Fallow 12 to 18 Nov	Mustard (BARI Sarisha-14- Boro (BRRI dhan84)- T. Aman (BRRI dhan71)	18 to 22 Nov 14 to 15 Feb 18-20 Aug	4 to 5 Feb 28-30 Apr 10 to 12 Nov
	Boro (BRRI dhan28)- Fallow T. Aman - (Swarna)	8 to18Jan Fallow 28 to 30Aug	1 2 to15 May Fallow 14 to 20 Nov	Mustard (BARI Sarisha-14)- Mung bean (BARI Mung-6)- T. Aus (BRRI dhan48)- T. Aman (BRRI dhan71)	16 to 19 Nov 15 to17 Feb 8 to 9 May 17 to 20 Aug	4 to 5 Feb 28 to 30 April 9 to 10 Aug 10-12 Nov
	Fallow-Fallow- T. Aman (Swarna)	Fallow Fallow 29 to 31 Aug	Fallow Fallow 29 to 31 Aug 14-16 Nov	Mustard (BARI Sarisha-14)- Mungbean (BARI Mung-6)- T. Aus (BRRI dhan48)- Black gram (BARI Mash -4)	18 to Nov 20 to26 Feb 9 to 15 May 1 to7 Sept	10 to 15 Feb 25 to 30 April 10 to 13 Aug 4 to10 Nov

b) On-farm verification/production program

Bangladesh Agricultural Research Institute and other NARS Institutes have developed a large number of modern varieties of different crops, which are high yielder as well as short in duration. To identify the suitable crops and varieties, on-farm verification trial was conducted during years of 2018 to 2021 with different types of crops e.g., Mustard, Potato, Tomato, Wheat, Mungbean, Sesame, Lentil, Barley, Okra, Radish, etc. The identified suitable varieties were brought under production program at each location in the following years. The details of crop management are given in result part.

Table 10.10. Different operations conducted for production program at different FSRD sites under plainland ecosystem during the years of 2018 to 2021.

Location	Crop	Variety	No. of farmers	Total area (ha)	Date of sowing/ transplanting	Date of harvesting
Ajoddhapur Rangpur	Mustard	BARI Sarisha-14	6	1	21-28 Nov.	27-28 Feb.
		BARI Sarisha-18	2	1	20-30 Nov.	7-8 March
	Tomato	BARI Tomato-15	3	0.5	16-18 Nov.	15 Feb-09 March
	Potato	BARI Alu-25	7	1.4	28-30 Nov.	27Feb.-05 March
		BARI Alu-53	5	1	30 Nov-10 Dec	04-10March
Ganggarampur, Pabna	Mustard	BARI Sarisha-17	4	0.5	2-5 Dec.	13-15 March
	Lentil	BARI Masur-8	4	0.5	1-5 Dec.	15-20 March
	Pea	BARI Motor-3	9	1.0	25-28 Nov.	5-10 March
Sholakundu, Faridpur	Mustard	BARI Sarisha-14	3	0.24	8-15 Nov 18	6-12 February
		BARI Sarisha-18	3	0.3	30 Nov. -3 Dec.	9-11 March
	Wheat	BARI Gom-28	4	0.4	30 Nov. -2 Dec.	24-25 March
		BARI Gom-33	3	0.4	30 Nov. -8 Dec.	19-27 March
	Mungbean	BARI Mung-6	2	0.16	5 Mar	12-27 May (2 picking)
		BARI Mung-8	3	0.24	1-2 March	9-10 May (1 picking)
	Sesame	BARI Til-4	3	0.24	8-12 Mar	1-3 June
		BARI Til-4	4	0.25	19-25 March	15-22 June
	Lentil	BARI Masur-6	3	0.3	28 Nov.-3 Dec.	20-22 March
		BARI Masur-8	4	0.25	19 Nov-3 Dec	22-25 March
	Onion	BARI Piaj-1	3	0.3	4-14 Jan	24-31 March
		BARI Piaj-4	3	0.3	1-10 Jan	24-31 March
		BARI Piaj-1	4	0.5	30 Dec-10 Jan	22-25 March
		BARI Piaj-4	4	0.5	30 Dec-10 Jan	26-31 March
	Bottle gourd	Hybrid	1	0.06	25 July	25 Sep-20 Nov.
	Summer Tomato	BARI Hybrid Tomato-11	1	0.012	16 Aug	7-31 October
	Black gram	BARI Mash-3	2	0.2	17 Sep	3 December
	Intercropping of Radish + Onion bulb + Red amaranth with Sugarcane	Radish (BARI Mula-1), Onion (BARI Piaj -1), Red amaranth (BARI Lalshak-1), Sugarcane (Gendari local)	1	0.06	Sugarcane: 28 Oct Radish+Onion+red amaranth: 1 Nov	Sugarcane: 5-18 October Radish: 1-5 Jan. Onion: 5-10 Jan. Red amaranth: 4-5 December

Location	Crop	Variety	No. of farmers	Total area (ha)	Date of sowing/ transplanting	Date of harvesting
Atia, Delduar, Tangail	Mustard	BARI Sarisha-14	29	5.53	14-24 Nov.	03-11 Feb.
		BARI Sarisha-17	25	3.90	16-24 Nov.	5-12 Feb.
	Barley	BARI Barley-6	8	1.15	20-26 Nov.	15 Feb-09 March
		BARI Barley-7	7	1.11	22-26 Nov.	17-19 March
	Potato	BARI Alu-41	21	2.92	25 Nov.- 04 Dec	20-27 Feb.
Tarakandi, Sherpur	Mustard	BARI Sarisha-14	1	124 dec	03-06 Nov.	21-22 Jan.
	Okra	Shakti (Hybrid)	1	15 dec	15-18 March	1-25 May
	Potato	BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-40 & BARI Alu-41	1	124 dec	28-3 0 Nov.	19-20 Feb.

C. Livestock Production System

Productivity and profitability of livestock sector mostly depend on farm animal health and maintaining of livestock health is an integral part of integrated farming. Cattle health may be improved through deworming which may make the farmer economically benefitted. More than 10 faeces sample of cattle were selected from different location by the symptomatic parasitic infection and then investigated the parasites through faeces sample analysis for the confirmation. After confirmation of parasitic infestation, the tested animal was de-wormed by broad spectrum anthelmintics i.e., Trilev-vet (Livamisole and Triclabendazole) for round worm and liver fluke as per recommendation for the body weight. After deworming, Vitamin A, D and E containing injections were also being injected in cattle. Proper vaccination against four major diseases may reduce the mortality rate of cattle. For this purpose a short FGD was conducted to identify the disease severity and mortality after vaccination. In the vaccinated group Anthrax vaccine, Foot and mouth disease (FMD) vaccine, Black quarter (BQ) vaccine and Hemorrhagic septicemia (HS) vaccine were injected as per recommended schedule. Cattle fattening and Calf rearing programs were also continued at some areas.

Besides of cattle product, cowdung is very important by-product for integrated farming and farmers were motivated to use it for preparation of farm yard manure (FYM) including other homestead westage instead of using the cowdung as fuel.

Napier grass was identified as a suitable and profitable green fodder to produce in the homestead and its surrounding areas especially on pond bank. Farmers were advised to apply FYM after every cut of grass. It was introduced among the farmers for feeding their cattle. Some farmers were also selling their produced Napier grass in the market besides of feeding their cattle.

Poultry rearing is a common practice in rural Bangladesh. Disease is the main problem faced by the farmers in poultry rearing. Only proper vaccination can reduce the mortality rate of poultry. To reduce mortality rate and investigating effectiveness of poultry vaccine at farmers' level this program was conducted. A good number of poultry birds were vaccinated during the project period. In the vaccinated group BCRDV, RDV, Fowl pox, Fowl cholera and Duck plague vaccines were used as per recommended schedule. Regular contact was done by the facilitator team for providing necessary suggestions to solve their specific problems. Chick rearing, Pigeon rearing, Duck rearing and Turkey rearing programs were also conducted at some locations.

D. Fisheries Production System

Improper management is the major hindrance against profitability of fish culture in pond. The carp polyculture and monoculture of Tilapia, Pabda, Shing, Tengra etc. programs were undertaken in perennial and seasonal ponds at the FSRD sites with the objectives of increasing farmer's income and reducing protein deficiency of rural people. For fish cultivation, weeds and wild fishes were removed from the pond and lime was given at the rate of 1 kg per decimal as well as prepared for stocking with organic manure (cow dung) at the rate of 3 kg per decimal (Ahmed 1993). Fingerlings stocking density is mostly depending

on fingerlings size, species, pond depth, feed availability etc. However, in polyculture system, Silver carp, Catla, Rui, Mrigal, Common and Mirror carp may release form 20–30%, 10–15%, 15–20%, 10–15% and 15–20% respectively maintaining 20-30 fingerlings decimal-1 (Miah, et al., 1997). Fish feed was collected partially by the co-operative farmers whereas lime and fingerlings were supported from the program. Periodic checking and suggestions were given by the office personnel of the respective FSRD site.

E. Off-Farm Activities

Off-farm income refers to the portion of farm household income obtained off the farm, including non-farm wages and salaries, pensions, and interest earned by farm families. Since the last three decades or so, there has been increasing evidence showing that small-holder farm households in developing countries rarely rely on agriculture alone, but often maintain a portfolio of income activities in which off-farm activities are an important component (Barrett *et al.,* 2001).

Some farm families especially the women were engaged with off-farm activities. Some farmers had small grocery shop and opened at his off-time and also had practice of weaving Katha and cloth sewing with machine. Commercially cooking is also practiced in some cases by the men. The women were also engaged in making Kumra bora, Pilo cover, making handicrafts with rope, plastic ball etc. during their leisure periods and men were engaged with basket making and van/rickshaw pulling.

F. Local Service Provider (LSP)

For the better execution of farming activities and to make them more sustainable, one male and one female Local Service Provider (LSP) was selected from the co-operator farmers. The LSP was selected based on their knowledge level, eagerness, technology understanding and dissemination capability, local and social acceptance, etc.

G. Integration among different components

Integrated farming consists of several enterprises like home gardening with vegetables and fruits, crops and cropping system, dairying, poultry, fishery, etc. and these enterprises are interrelated. The end product and wastage of one enterprise may use as inputs in another enterprise. Moreover, judicious use of farm resources may reduce production cost and can help to keep clean the environment. In integrated farming, the contribution of one component on other component ('s) is important consideration for sustainable farming.

11. Results and Discussion

A. Homestead Production System

11.1 Year-round vegetables and fruits production in homestead area of FSRD Sites during 2018 to 2021

BARI Component

FSRD Site: Ajoddhapur, Rangpur

Vegetables production: The vegetables cultivation program at homestead area was carried out for three consecutive years at FSRD site, following the "Syedpur Model" from February 2018 to January 2021 (Table 11.1.1). From the results, it was found that open sunny place contributed more for vegetables production followed by back yard and trellis in all the years and the average vegetables production from open sunny place was 248 kg homestead^{-1} year^{-1} (Table 11.1.2 and 11.1.3). From the Table 11.1.1 it was observed that, the vegetables production was maximum in Rabi season (275, 239 and 305 kg homestead^{-1} in 1st, 2nd and 3rd year, respectively) followed by Kharif-2 season. The second highest vegetables were obtaind in Kharif-2 season except in 2nd and 3rd year, the less vegetables were due to damage by severe flood. The total vegetables production was in increasing trend in 2nd year compared to 1st year but in 3rd year, it was decreased due to almost fully damage of Kharif-2 vegetables by severe flood (Table 11.1.2 and 11.1.3). Round the year total vegetables produced 516, 595 and 574 kg homestead^{-1} were in 1st, 2nd and 3rd year, respectively and it was partially contributed by the total number of available production niches. After intervention of the improved technologies, the average vegetables production was increased 290%

compared to before intervention of the program. Using of improved technologies and judicious time management for vegetables production might be enhanced the remarkable increment of vegetable production in homestead area.

Picture 11.1. Vegetables production at homestead area of FSRD Site, Ajoddhapur, Rangpur

Utilization of vegetables: The disposal pattern of different vegetables produced in the homestead area was recorded regularly through the help of the co-operator farmers (Table 11.1.3). The average vegetables intake per year per 5 members farm family was 412 kg after program intervention and the increment was 308%, whereas intake was only 101 kg per farm family per year before program intervention. The average vegetables intake by a 5 member's farm family was increased remarkably and it was 226 g head^{-1} day^{-1}. After intervention, the average distribution of vegetables per year was recorded as 46 kg and average sell was 104 kg. Increased production of vegetables encouraged the farm families to distribute relatively more vegetables to their relatives and neighbor, which might be helpful to increase their relationship and also helped them to earn more money from more selling of vegetables. The better utilization of homestead area with optimum management by effective farm family labor can be achieved for optimum vegetables production and subsequent intake, distribution and sell.

Picture 11.2. Vegetables utilization pattern of FSRD Site, Ajoddhapur, Rangpur

Fruits production: Different types of quick growing fruit trees (Dragon fruit, Papaya, Lemon, Banana etc.) along with other existing fruit trees (Mango, Jackfruit, Coconut, Wood apple etc.) were managed through pruning, pest control, fertilization and irrigation. After intervention, fruits production was increased significantly. Table 11.1.1 showed that higher quantity of fruits production was obtained from Kharif-1 (699, 572, 570 kg homestead^{-1} in 1st, 2nd and 3rd year, respectively,) season followed by Kharif-2 (55, 167, and 63 kg homestead^{-1}). Minimum fruits were produced during Rabi season and it is actually due to less availability of Rabi (winter) fruits species and variety (Table 11.1.1). After implementation of the program, the average fruits production was increased 110% due to use of improved technologies including judicious fertilizer management and pest control (Table 11.1.2).

Picture 11.3. Fruits production of FSRD Site, Ajoddhapur, Rangpur

Utilization of fruits: The disposal pattern of different fruits produced under homestead area was recorded timely in three consecutive years. The three years average fruits intake per year per farm family was 359 kg after program intervention, whereas it was only 264 kg before intervention and the 36% increment was mainly due to increment of total production and motivation (Table 11.1.3). After intervention, the average distribution of fruits per year was recorded as 113 kg and sell of fruits per year was 291 kg. Increased production of fruits encouraged the farm families to distribute towards their relatives and neighbor, but the farmers were more interested to sell fruits for getting some cash money.

Income: In case of vegetables, after intervention of homestead production system, the income was Tk. 6910, 14140 and 13269 in 1st , 2nd and 3rd year, respectively,. The average increment of income was 511% after intervention compared to before intervention (Table 11.1.2). In case of fruits sector, after intervention, income per homestead was recorded as Tk. 11933, 19850 and 17450 in 1st , 2nd and 3rd year, respectively. The income was increased in 2nd year but decreased in 3rd year due to damage of fruit trees especially Papaya by flood. The average increment of gross margin was 216% after intervention compared to before intervention (Table 11.1.3).

Table 11.1.1. Round the year vegetables and fruits production per homestead area during 2018 to 2021 at FSRD site, Ajoddhapur, Rangpur.

Space		Rabi			Kharif-1			Kharif-2			Total (Kg)		
		October- March			April-June			July-September					
		Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III
Open sunny space	Bed-1	45.4	26	28	4	13	15	12	21	5	61.4	60	48
	Bed-2	48.5	29	35	7	26	19	2	4	0	57.5	59	54
	Bed-3	21	20	24	6	23	20	7	24	3	34	67	47
	Bed-4	23.5	32	28	5	20	22	12	13	0	40.5	65	50
	Bed-5	0	8	21	7	17	18	8	23	0	15	48	39
Roof		21	23	35	14	0	10	20	16	10	55	39	55
Trellis		50	33	41	15	23	26	18	14	5	83	70	72
Fence		11.2	2	7	4	6	8	5	0	0	20.2	8	15
Tree support		11.5	0	8	5	0	5	4	7	2	20.5	7	15
Marshy land		14.5	0	3	0	3	8	11	9	13	25.5	12	24
Backyard		15.5	27	23	12	31	28	22	30	10	49.5	88	61
Partially shady place		0	19	18	11	3	7	12	4	2	23	26	27
House boundary		1	3	11	2	4	6	4	6	10	7	13	27
Pond bank		12	17	23	5	9	15	7	8	2	24	34	40
Total (vegetable)		275	239	305	97	178	207	144	179	62	516	595	574
Fruits		42	55	65	699	572	570	55	167	63	796	794	698
Total (vegetables +fruit)		317	294	370	796	750	777	199	346	125	1312	1389	1272

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.2. Round the year vegetables and fruits production and income per homestead during 2018 to 2021 at FSRD site, Ajoddhapur Rangpur.

Niches	Before intervention		After intervention									
			Year I		Year II		Year III		Average of 3 years		Avg. increment over before intervention	
	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income
Open sunny space	0	0	208	2080	299	4485	238	3570	248	3378	248	3378
Roof	0	0	55	825	39	780	55	1100	50	902	50	902
Trellis	86	1295	83	1328	70	1540	72	1584	75	1484	-11	189
Fence	0	0	20.2	828	8	232	15	450	14	503	14	503
Tree support	0	0	20.5	290	7	133	15	315	14	246	14	246

Niches	Before intervention		After intervention									
			Year I		Year II		Year III		Average of 3 years		Avg. increment over before intervention	
	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income
Marshy land	0	0	25.5	510	12	240	24	528	21	426	21	426
Backyard	36	356	49.5	495	87	5220	61	3965	66	3227	30	2871
Partially shady place	22	220	23	230	26	1040	27	1080	25	783	3	563
House boundary	0	0	7	84	13	130	27	270	16	162	16	162
Pond bank	0	0	24	240	34	340	40	407	33	329	33	329
Total (vegetables)	144	1871	516	6910	595	14140	574	13269	562	11440	418	9569
Fruits	363	5438	796	11933	794	19850	698	17450	763	16411	400	10973
Total (vegetables +fruit)	507	7309	1312	18843	1389	33990	1272	30719	1324	27851	818	20542

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.3. Round the year vegetables & fruits production and utilization pattern before and after intervention during 2018 to 2021 at FSRD site, Ajoddhapur, Rangpur.

Description	Before intervention		After intervention							
	Vegetables (kg)	Fruit (kg)	Vegetables (kg)				Fruits (kg)			
			Year I	Year II	Year III	Avg. three years	Year I	Year II	Year III	Avg. three years
Consumption	101	264	396	465	375	412	439	305	332	359
Distribution	28	54	38	35	65	46	145	95	99	113
Selling	15	45	82	95	134	104	212	394	267	291
Total production	144	363	516	595	574	562	796	794	698	763
Gross return (Tk.)	1871	5438	6910	14140	13269	11440	11933	19850	17450	16411
Variable cost (Tk.)	650	1250	2720	2739	2480	2646	3175	3240	3150	3188
Gross margin (Tk.)	1221	4188	4190	11401	10789	8793	8758	16610	14300	13223

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna

Vegetables production: Available and utilizable production niches of the homestead areas were brought under Goyeshpur model. After intervention of the proven and improved technologies in the homestead, vegetables production has increased remarkably with an average vegetables production was (459 kg homestead^{-1}) in Rabi season followed by Kharif-1 (278 kg homestead^{-1}) and Kharif-2 (271 kg homestead^{-1}) season (Table 11.1.4).

After intervention of the improved technologies, vegetables production was increased 134% compared to before intervention of the program (Table 11.1.5). The remarkable increment of vegetables production in homestead area might be enhanced by using improved technologies and optimum management practices.

Picture 11.4. Vegetables production at homestead area of FSRD Site Ganggarampur, Pabna

Utilization of vegetables: The disposal pattern of different vegetables produced in the homestead area was recorded regularly through the help of the co-operator farmers (Table 11.1.6). The average vegetables intake per year per farm family was 466 kg after intervention and the increment was 122% where as intake was only (255 kg per family per year) before intervention. Vegetables intake of 5 member's farm family was increased remarkably and it was on an average 255 g head^{-1} day^{-1}. After intervention, the average distribution and sell of vegetables per farm per year was recorded as 72 kg and 392 kg, respectively. Increased production of vegetables encouraged the farm families to distribute relatively more vegetables to their relatives and neighbor, which might be helpful to earn more money from selling of vegetables. The better utilization of homestead area with optimum management by effective farm family labor can be achieved for optimum vegetables production and subsequent intake, distribution and sell.

Picture 11.5. Vegetables utilization pattern of FSRD Site, Ganggarampur, Pabna

Fruits production: Different types of quick growing fruit trees (Guava, Papaya, Lemon, Ber, Banana etc.) along with other existing fruit trees (Mango, Jack fruit, Coconut, Wood apple, Pummelo etc.) were managed through pruning, pest control, fertilization and irrigation. After intervention, fruits production has increased remarkably (Table 11.1.6). Higher quantity of average fruits production per year per farm was found in Kharif-2 (537 kg homestead^{-1}) followed by Kharif-1 (410 kg homestead^{-1}) and Rabi (283 kg homestead^{-1}) season. Maximum fruits were produced during Kharif-2 season and minimum fruits were produced during Rabi season and it is actually due to less availability of Rabi (winter) fruits species and variety. After implementation of the program, the fruits productions were increased 47% due to use of improved technologies including judicious fertilizer management and disease and pest control.

Picture 11.6. Fruit production at FSRD Site, Ganggarampur, Pabna

Utilization of fruits: The disposal pattern of different fruits produced under homestead area was recorded timely on three years. The average fruits intake per year per farm family was 599 kg after intervention which was 103% higher as compared to before intervention (295 kg per family per year) mainly due to incremental production (Table 11.1.6). After intervention, the distribution of fruits per year per family was recorded 175 kg and selling of fruits per year per family was 456 kg. Increased production of fruits encouraged the farm families to distribute towards their relatives and neighbor, and the farmers were sold their fruits for getting satisfactory cash money.

Picture 11.7. Fruit utilization pattern of FSRD Site, Ganggarampur, Pabna

Income: In case of vegetables, after intervention of homestead production system average gross return and gross margin was recorded 13955 and Tk. 10696 per year per farm whereas gross return and gross margin 4566 and Tk. 3818 per year per farm was noted before intervention. From the fruits sector, after

program intervention, average gross return and gross margin was recorded as 31158 and Tk. 24391 per year per farm whereas gross return and gross margin 16700 and Tk. 13775 per year per farm was noted before intervention (Table 11.1.6).

Table 11.1.4. Round the year vegetables and fruits production per homestead area during 2018 to 2021 at FSRD site, Ganggarampur, Pabna.

Space		Rabi			Kharif-1			Kharif-2			Total (kg)		
		Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III
open sunny space	Bed-1	30	43	60	22	27	31	20	21	25	72	91	116
	Bed-2	45	47	65	25	19	27	10	16	14	80	82	106
	Bed-3	30	41	57	26	22	23	12	12	14	68	75	94
Roof top		40	31	42	35	-	1	15	-	19	90	31	77
Trellis		60	56	69	17	21	25	30	20	30	107	97	124
Shady place		45	21	35	60	23	26	50	32	30	155	76	91
Marshy land		-	-	-	40	24	22	25	34	25	65	59	47
Unproductive tree		21	13	24	-	9	12	10	10	10	31	32	46
Fence		16	16	18	10	14	12	10	8	6	36	38	36
Backyard		18	25	40	35	33	41	45	54	32	98	112	113
House boundary		38	48	49	45	40	52	50	65	60	133	153	161
Total vegetables		343	341	459	315	232	286	277	272	264	935	845	1011
Fruits		275	245	329	430	395	406	545	505	561	1250	1145	1296
Total (veg. + fruits)		618	586	788	745	627	692	822	777	825	2185	1990	2307

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.5. Round the year vegetables & fruits production and income per homestead during 2018 to 2021 at FSRD site, Ganggarampur, Pabna.

Niches	Before intervention		After intervention									
			Year I		Year II		Year III		Average of three years		Avg. increment over before intervention	
	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)
Open sunny place	-	-	220	3530	248	3852	316	4740	261	4040	261	4040
Roof top	25	288	90	2035	31	357	77	1155	66	1182	41	894
Trellis	75	862	107	1230	97	1116	124	1860	109	1402	34	540
Shady place	90	1035	155	1783	76	874	91	1365	107	1340	17	305
Marshy place	50	575	65	748	59	678	47	705	57	710	7	135
Unproductive tree	12	138	31	356	32	368	46	690	36	471	24	333
Fence	-	-	36	414	38	437	36	540	37	464	37	464
Backyard	60	690	98	1127	112	1288	113	1695	108	1370	48	680
House boundary	85	978	133	1530	153	1760	161	2415	149	1901	64	923
Total	397	4566	935	10753	845	9717	1011	15165	930	11880	533	7314
Fruit (Other places)	835	16700	1250	25000	1145	22900	1296	32400	1230	26766	395	10066
Total (veg. + fruit)	1232	21266	2185	35753	1990	32617	2307	47565	2160	38646	928	17380

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1. 6 Round the year vegetables & fruits production and utilization pattern before and after intervention during 2018 to 2021 at FSRD site, Ganggarampur, Pabna.

Description	Before intervention		After intervention					
	Vegetables (kg)	Fruits (kg)	Vegetables (kg)			Fruits (kg)		
			Year I	Year II	Year III	Year I	Year II	Year III
Consumption	210	295	472	450	475	607	550	641
Distribution	37	118	56	70	91	135	175	215
Selling	150	422	407	325	445	508	420	440
Total production	397	835	935	845	1011	1250	1145	1296
Gross return (Tk.)	4566	16700	14025	12675	15165	31875	29198	32400
Variable cost (Tk.)	748	2925	3273	2958	3539	6875	6298	7128
Gross margin (Tk.)	3818	13775	10753	9717	11626	25000	22900	25272

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sholakundu, Faridpur

Picture 11.8. Vegetables production at FSRD Site, Sholakundu, Faridpur

Vegetables and fruit production: The vegetables cultivation program at homestead area was carried out at FSRD site following Ishan Gopalpur model using nine niches for 2018 to 2021 (Table 11.1.7). After intervention of improved technologies, vegetables production has increased significantly and the most remarkable change was observed in case of vegetables produced at open sunny place (Table 11.1. 7). Vegetables production was increased on first two years but in the third year (Feb. 2020 to Jan. 2021), vegetables production was decreased due to incomplete Rabi 2020-21 vegetables. The total vegetables production was 566 kg, 831 kg, 820 kg per homestead during during 1st, 2nd and 3rd year, respectively (Table 11.1.7). Average increment of vegetables production and income over before intervention was 565 kg and 510%, respectivley (Table 11.1.8). Vegetables production in homestead area was enhanced remarkably might be due to effectively use of different production niches, improved technologies and judicious management.

Picture 11.9. Fruit production at FSRD Site, Sholakundu, Faridpur

Improved management through pruning, pest control, fertilization and irrigation in quick growing fruit trees (Guava, Papaya, Lemon, Ber, Banana etc.) along with other existing fruit trees (Mango, Jackfruit, Coconut, Golden apple etc.) were provided after program intervention and as a result, fruits production has increased significantly. The total fruit production was 167 kg, 200 kg, 390 kg per homestead during 1st, 2nd and 3rd year, respectively. Average increment of fruit production and income over before intervention was 128 kg and 78%, respectivley. Minimum fruits were produced during Rabi season and it is actually due to less availability of Rabi (winter) fruits species and variety. In every homestead, a total of 991 kg of fruit and vegetables were produced and income was Tk. 19485 showing 211% income increment over before intervention (Table 11.1.8).

Utilization of vegetables and fruits: During before intervention, vegetables consumption, distribution and selling were 101 kg, 14 kg and 59 kg, respectivley whereas after intervention, vegetables consumption, distribution and selling were 512 kg, 48 kg and 178 kg, respectively (Table 11.1.9). After program intervention, the fruits consumption per year per farm family were 71 kg, 155 kg and 225 kg during 1st, 2nd and 3rd year, respectively. Thus, it is concluded that, consumption ratio was increasing year wise. Average gross margin after intervention for vegetables and fruits were 9868 and Tk. 6617, respectively.

Picture 11.10. Utilization of vegetables and fruit at FSRD Site, Sholakundu, Faridpur

Table 11.1.7. Round the year vegetables and fruits production per homestead area during 2018 to 2021 at the FSRD site, Sholakundu, Faridpur.

Space		Rabi			Kharif-1			Kharif-2			Total (Kg)		
		October- March			April-June			July-September					
		Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III
Open sunny space	Bed-1	35	60	54	12	22	22	16	27	24	64	109	100
	Bed-2	21	51	50	21	18	18	17	23	25	60	92	93
	Bed-3	31	39	51	11	21	19	9	15	24	51	75	94
	Bed-4	24	37	50	13	15	21	11	19	20	48	71	91
	Bed-5	18	36	41	12	18	14	14	18	19	43	72	74
	Bed-6	21	31	45	15	22	17	12	19	21	47	72	83
Roof top		18	17	16	13	8	5	10	21	7	42	46	28
Trellis		27	47	49	21	23	18	16	36	27	64	106	94
Tree support		1	12	10	2	5	4	1	9	8	4	26	22
Shady Place		8	5	09	8	7	7	8	16	8	24	28	24
Marshy Land		3	4	05	3	6	5	5	14	7	11	24	17
Backyard		11	13	10	14	11	3	18	20	3	43	44	16
Homestead Boundary		16	17	24	16	11	12	13	21	17	45	49	53
Pond bank		8	9	14	6	4	8	6	4	9	20	17	31
Total (vegetable)		243	378	428	167	191	173	156	262	219	566	831	820
Fruits		22	38	71	107	91	205	38	71	114	167	200	390
Total (veg. +fruit)		432	416	499	274	282	378	194	333	333	733	1031	1210

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.8. Round the year vegetables & fruits production and income per homestead during 2018 to 2021 at FSRD site, Sholakundu, Faridpur.

Niches	Before intervention		After intervention									
			Year I		Year II		Year III		Avg. of three years		Avg. increment over before intervention	
	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (%)
Open sunny place	0	0	313	4457	491	6870	535	9630	446	6986	446	--
Roof top	12	144	42	598	46	828	28	504	39	643	27	347
Trellis	61	732	64	911	106	1908	94	1692	88	1504	27	105
Tree support	0	0	4	57	26	390	22	396	17	281	17	
Shady Place	11	110	24	342	28	336	24	432	25	370	14	236
Marshy Land	10	100	11	157	24	288	17	306	17	250	7	150
Backyard	18	180	43	612	44	660	16	288	34	520	16	189
Homestead Boundary	47	494	45	641	49	931	53	954	49	842	2	70
Pond bank	15	168	20	285	17	255	31	558	23	366	8	118
Total	174	1928	566	8060	831	12466	820	14760	739	11762	565	510
Fruit (other places)	124	4340	167	5833	200	7000	390	10335	252	7723	128	78
Total (vegetables+fruit)	298	6268	733	13893	1031	19466	1210	25095	991	19485	693	211

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.9. Round the year vegetables & fruits production and utilization pattern before and after intervention during 2018 to 2021 at FSRD site, Sholakundu, Faridpur.

Description	Before intervention		After intervention							
			Vegetables (kg)				Fruits (kg)			
	Vegetables (kg)	Fruit (kg)	Year I	Year II	Year III	Avg.of three years	Year I	Year II	Year III	Avg. of three years
Consumption	101	65	324	633	580	512	71	155	225	150
Distribution	14	25	44	51	50	48	34	22	68	41
Selling	59	34	198	147	190	178	62	23	97	61
Total production	174	124	566	831	820	739	167	200	390	252
Gross return (Tk.)	1928	4340	8060	12466	14760	11762	5833	7000	10335	7723
Total Variable cost (Tk.)	276	280	2350	1513	1820	1894	1130	860	1328	1106
Gros margin (Tk.)	1652	4060	5710	10953	12940	9868	4703	6140	9007	6617

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail

Vegetables production: Available and utilizable production niches of the homestead areas were brought under cultivation with following Palima model by utilizing seven niches. After intervention, it was observed that the average vegetables production was (664 kg homestead^{-1}) in Rabi season followed by Kharif-2 (546 kg homestead^{-1}) and Kharif-1 (437 kg homestead^{-1}) season (Table 11.1.10).

Picture 11.11. Vegetables production at FSRD Site, Atia, Tangail

Utilization of vegetables: The results indicated that the average vegetables intake per year per farm family was 283 kg after intervention and the increment was 529%, whereas intake was only 45 kg per farm family per year before intervention (Table 11.1.12). Vegetables intake by 5 member's farm family was increased remarkably and it was on an average 155 g head^{-1} day^{-1}. After intervention, the distribution of vegetables per year was recorded 32 kg and sell of vegetables per year was 233 kg. The better utilization of homestead area with optimum management by effective farm family labor can be achieved for optimum vegetables production and subsequent intake, distribution and sell.

Picture 11.12. Utilization of vegetables at FSRD Site, Atia, Tangail

Fruits production: Quick growing fruit trees (Guava, Papaya, Lemon, Ber, Banana etc.) along with other existing fruit trees (Mango, Jack fruit, Coconut, Wood apple pummelo etc.) were managed through pruning, pest control, fertilization and irrigation. After intervention higher quantity of average fruits production was found in Kharif-1 (112 kg homestead^{-1}) season followed by Kharif-2 (87 kg homestead^{-1}) and Rabi (86 kg homestead^{-1}) season, which was more or less the reverse scenario of vegetables production (Table 11.1.10). After intervention, the fruits production was increased 48% compared to before intervention of the program (Table 11.1.11). Using of improved technologies including judicious fertilizer management in fruits production has increased the yield tremendously.

Picture 11.13. Fruits production at FSRD Site, Atia, Tangail

Utilization of fruits: The average fruits intake per year per farm family was 62 kg after program intervention, whereas it was only 40 kg before intervention and the 55% increment was mainly due to increment of total production (Table 11.1.12). Average fruit intake by a member of 5 members farm family was 34 g head^{-1} day^{-1}. After program intervention, the distribution of fruits per year was recorded 9 kg and sell of fruits per year was 26 kg. Increased production of fruits encouraged the farm families to distribute towards their relatives and neighbor, but the farmers were more interested in sell for getting some cash money.

Picture 11.14. Utilization of fruits at FSRD Site, Atia, Tangail

Income: After intervention, from the vegetables production average gross return per farm was recorded as Tk. 5828 with the average gross margin of Tk. 4141 which was only Tk. 536 before intervention. From the

fruits sector, after program intervention, average gross return per farm was recorded as Tk. 1940 with the average gross margin of Tk. 1505 which was only Tk. 917 before intervention (Table 11.1.12).

Table 11.1.10. Round the year vegetables and fruits production per homestead area during 2018 to 2021 at FSRD site, Atia, Tangail.

Space		Rabi			Kharif-1			Kharif-2			Total (Kg)		
		October- March			April-June			July-September					
		Year I	**Year II**	**Year III**	**Year I**	**Year II**	**Year III**	**Year I**	**Year II**	**Year III**	**Year I**	**Year II**	**Year III**
Open sunny space	Bed-1	38	43	23	11	14	11	23	33	15	72	90	49
	Bed-2	38	19	16	19	29	18	27	18	14	84	66	48
	Bed-3	32	27	27	13	31	10	19	31	17	64	89	54
	Bed-4	30	29	30	15	25	9	24	27	21	69	81	60
Roof top		0	14	19	17	13	6	15	18	13	32	45	38
Trellis		23	48	34	28	58	15	25	47	15	76	153	64
Shady Place		11	14	10	10	13	6	16	18	13	37	45	29
Marshy Land		15	7	15	17	9	3	9	11	0	41	27	18
Unproductive Tree		12	10	21	0	0	4	15	12	0	27	22	25
Fence		-	-	-	-	-	-	-	-	-	-	-	-
Backyard		16	19	24	13	14	6	17	19	14	46	52	44
House Boundary		-	-	-	-	-	-	-	-	-	-	-	-
Total (veg.)		215	230	219	143	206	88	190	234	122	548	670	429
Fruits		22	36	28	20	36	56	35	29	23	77	101	107
Total (veg. + fruit)		237	266	247	163	242	144	225	263	145	625	771	536

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.11 Round the year vegetables & fruits production and income per homestead during 2018 to 2021 at FSRD site, Atia, Tangail.

Niches	Before intervention		After intervention									
			Year I		**Year II**		**Year III**		Avg. of three years		Avg. increment over before intervention	
	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)	Production (kg)	Income (Tk.)
Open sunny place	24	298	289	2312	326	2608	211	2532	275	2484	251	640
Roof top	21	204	32	320	45	540	38	456	38	439	17	115
Trellis	11	244	76	760	153	1224	64	960	98	981	87	202
Fence	-	-	-	-	-	-	-	-	-	-	-	-
Tree support	0	0	27	270	22	264	25	375	25	303	25	100
Marshy place	0	0	41	328	27	324	18	144	29	265	29	100
Backyard	0	0	46	360	52	624	44	352	47	445	47	100
Partial shady place	0	0	37	740	45	540	29	1450	37	910	37	100
Total	56	746	548	5090	670	6124	429	6269	549	5828	493	608
Fruit (other places)	64	1280	77	1540	101	2020	107	2260	95	1940	31	46
Total (veg.+ fruit)	120	2026	625	6014	771	7639	536	8529	644	7768	524	226

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.12 Round the year vegetables & fruits production and utilization pattern before and after Intervention during 2018 to 2021 at FSRD site, Atia, Tangail.

Description	Before Intervention		After Intervention							
	Vegetables (kg)	Fruit (kg)	Vegetables (kg)				Fruits (kg)			
			Year I	**Year II**	**Year III**	Avg. of three years	**Year I**	**Year II**	**Year III**	Avg. of three years
Consumption	45	40	220	360	270	283	47	70	70	62
Distribution	02	5	20	46	31	32	9	7	11	9
Selling	09	19	308	264	128	233	21	24	32	26
Total production	56	64	548	670	429	549	77	101	107	95
Gross return (Tk.)	746	1280	5090	6124	6269	5828	1540	2020	2260	1940
Variable cost (Tk.)	210	363	1390	1980	1690	1687	410	440	456	435
Gross margin (Tk.)	536	917	3700	4144	4279	4141	1130	1580	1804	1505

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur

Vegetables production: Available and utilizable production niches of the homestead areas were brought under cultivation following Narekeli Model. After intervention, average vegetables production was (264 kg homestead^{-1}) in Rabi season followed by Kharif-1 (105 kg homestead^{-1}) and Kharif-2 (45 kg homestead^{-1}) season (Table 11.1.13). After intervention, income from vegetables production was increased 962% compared to before intervention (Table 11.1.14). The remarkable increment of vegetables production in homestead area might be enhanced by using modern technologies and judicious time management.

Picture 11.15. Vegetables production at FSRD Site, Tarakandi, Sherpur

Utilization of vegetables: The disposal pattern of different vegetables produced in the homestead area was recorded regularly through the help of the co-operator farmers (Table 11.1.15). The average vegetables intake per year per farm family was 129 kg after intervention and the increment was 616%, whereas intake was only 18 kg per farm family per year before intervention. Vegetables intake by a member of 5 member's farm family was increased remarkably on an average 70 g head^{-1} day^{-1}. After intervention, the distribution of vegetables per year was recorded 38 kg and sell of vegetables per year was 197 kg. The better utilization of homestead area with optimum management by effective farm family labor can be achieved for optimum vegetable production and subsequent intake, distribution and sell.

Picture 11.16. Utilization pattern of vegetables at FSRD Site, Tarakandi, Sherpur

Fruits production: The quick growing fruit trees (Guava, Papaya, Lemon, Ber, Banana, Coconut, Alubukhara, Malta etc.) along with other existing fruit trees (Mango, Jack fruit, Pummelo, etc.) were managed through pruning, pest control, fertilization and irrigation. Higher quantity of average fruits production was found in Kharif-2 (107 kg homestead^{-1}) season followed by Kharif-1 (93 kg homestead^{-1}) and Rabi (35 kg homestead^{-1}) season, which was more or less the reverse scenario of vegetables production (Table 11.1.13). Maximum fruits were produced during Kharif-2 season, minimum fruits were produced during Rabi season, and it is actually due to less availability of Rabi (winter) fruits species and variety. After intervention, the fruits production was increased 1583% compared to before intervention of the program. Using of modern technologies including judicious fertilizer management and disease and pest control in fruits production has increased the yield tremendously.

Picture 11.17. Fruits production at FSRD Site, Tarakandi, Sherpur

Utilization of fruits: The average fruits intake per year per farm family was 65 kg after intervention, whereas it was only 6 kg before intervention and the 983% increment was mainly due to increase total production (Table 11.1.15). After intervention, the distribution of fruits per farm year was recorded 13 kg and sell of fruits per farm year was 91 kg. Increased production of fruits encouraged the farm families to distribute towards their relatives and neighbor, but the farmers were more interested to sell for getting some cash money.

Income: After intervention, from the vegetables production average gross return per farm was recorded as Tk. 6531with the average gross margin of Tk. 5576 which was only Tk. 560 before intervention. From the fruits sector, after intervention, average gross return per farm was recorded as Tk. 2525 with the average gross margin of Tk. 2283 which was only Tk. 114 before intervention (Table 11.1.15).

Table 11.1. 13. Round the year vegetables and fruits production per homestead area during 2018 to 2021 at FSRD site, Tarakandi, Sherpur.

Space		Rabi			Kharif-1			Kharif-2			Total (Kg)		
		October- March			April-June			July-September					
		Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III
Open sunny space	Bed-1	5.8	40.98	29.99	0	12.1	11.39	0	4.46	8.87	5.8	57.54	50.25
	Bed-2	43.0	78.13	72.20	0	21.38	20.21	0	7.67	11.85	43.0	107.18	104.26
	Bed-3	9.47	10.47	6.40	0	18.49	13.34	0	4.26	9.03	9.47	33.22	28.77
	Bed-4	6.10	11.11	9.54	0	3.32	3.28	0	4.59	3.80	6.10	19.02	16.62
	Bed-5	25.50	13.57	17.8	0	10.9	12.08	0	8.33	14.39	25.50	32.8	44.27
Roof		81.00	85	33	0	0	50	0	0	0	81.00	85.00	83
Trellis		30.00	31	40	0	0	15	0	0	0	30.00	31.00	55
Fence		8.00	7	9	0	0	0	0	0	0	8.00	7.00	9
Unused tree		0	3.5	0	0	0	0	0	0	12	0	3.5	12
Marshy land		0	0	0	0	0	8	0	0	0	0	0	8
Backyard		0	4.5	12	0	0	0	0	0	0	0	4.5	12
Shady place		10.00	13	16	0	0	0	0		0	10.00	13	16

Space	Rabi			Kharif-1			Kharif-2			Total (Kg)		
	October- March			April-June			July-September					
	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III
House boundary	5.00	15	15	0	0	10	0	0	0	5.00	15.00	25
Total (vegetable)	218.87	313.26	260.93	0	66.19	143.3	*0*	*29.31*	59.94	218.87	408.8	464.17
Fruits	25.00	25	55	0	46	140	*0*	*34*	180	25.00	105	375
Total (veg. +fruit)	348.87	338.26	315.93	0	112.19	283.3	0	63.31	239.94	348.87	513.76	839.17

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.14. Round the year vegetables & fruits production and income per homestead during 2018 to 2021 at FSRD site, Tarakandi, Sherpur.

Niches	Before intervention		After intervention									
			Year I		**Year II**		**Year III**		Avg of three years.		Avg. increment over before intervention	
	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (%)
Open sunny place	22	215.00	89.87	879.70	249.76	4960.25	244.17	6104.25	194.60	3981.17	172.6	-
Roof	15	150.00	81.00	810.00	85.00	1020.00	83.00	1245.00	83.00	1025.00	68.00	-
Trellis	25	250.00	30.00	300.00	31.00	310.00	55.00	550.00	38.67	386.67	13.67	-
Fence	0	0	8.00	240.00	7.00	210.00	9.00	270.00	8.00	240.00	8.00	-
Unused tree	0	0	0	0	3.50	105.00	12.00	360.00	5.17	155.00	5.17	-
Marshy land	0	0	0	0	0	0	8.00	160.00	2.67	53.33	2.67	-
Backyard	0	0	0	0	4.50	90.00	12.00	240.00	5.50	110.00	5.50	-
Shady place	0	0	10.00	200.00	13.00	260.00	16.00	480.00	13.00	313.33	13.00	-
House boundary	0	0	0	0	15.00	300.00	25.00	500.00	13.33	266.67	13.33	-
Total (vegetable)	62	615.00	218.87	2429.70	408.76	7255.25	464.17	9909.25	363.94	6531.17	301.94	962
Fruits	10	150.00	25.00	375.00	105.00	1575.00	375.00	5625.00	168.33	2525.00	158.33	1583
Total (veg. +fruit)	72	765.00	243.87	2804.70	513.76	8830.25	839.17	15534.25	532.27	9056.17	460.27	1083

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.1.15. Round the year vegetables & fruits production and utilization pattern before and after intervention during 2018 to 2021 at FSRD site, Tarakandi, Sherpur.

Description	Before intervention		After intervention							
	Vegetables (kg)	Fruit (kg)	Vegetables (kg)				Fruits (kg)			
			Year I	**Year II**	**Year III**	Avg. of three years	**Year I**	**Year II**	**Year III**	Avg. of three years
Consumption	18	6	76.00	126.00	186.17	129.39	5	39	150	64.67
Distribution	6	0	21.00	55.00	38.00	38.00	4	10	25	13
Selling	38	4	121.87	227.76	240.00	196.54	16	56	200	90.67
Total production	62	10	218.87	408.76	464.17	363.93	25	105	375	168.33
Gross return (Tk.)	615	150	2429.70	7255.25	9909.25	6531.40	375.00	1575.00	5625.00	2525.00

Description	Before Intervention		After Intervention							
	Vegetables (kg)	Fruit (kg)	Vegetables (kg)				Fruits (kg)			
			Year I	Year II	Year III	Avg. of three years	Year I	Year II	Year III	Avg. of three years
Variable cost (Tk.)	55.00	36.00	5011.00	1103.00	1250.00	954.66	86.00	156.00	485.00	242.33
Gross margin (Tk.)	560.00	114.00	1918.70	6152.25	8659.25	5576.73	289.00	1419.00	5140.00	2282.67

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

BRRI Component

FSRD Site: Sreepur, Gazipur

After intervention vegetables and fruits, production among nine different niches was increased. Average vegetables production was maximum during rabi season (91 kg farmer^{-1}) followed by kharif-2 (67 kg farmer-1) and kharif-1 (46 kg farmer^{-1}). During rabi season, the highest production was found during 1st year (103 kg farmer^{-1}) followed by 2nd year (93 kg farmer^{-1}). During kharif-2 season, the highest yield was obtained from 3rd year (79 kg farmer^{-1}) followed by 1st year (62 kg farmer^{-1}). During kharif-1 season, maximum production was obtained in the 3rd year (55 kg farmer^{-1}) followed by 2nd year (48 kg farmer^{-1}). Total highest production of vegetables was found during 3rd year (210 kg farmer^{-1}) followed by 2nd year (201 kg farmer^{-1}) and the lowest production (200 kg farmer^{-1}) was obtained during 1st year. Maximum Fruits production from other places of the homestead was found during 2nd year (97 kg farmer^{-1}) followed by 1st year (87 kg farmer^{-1}) (Table 11.1.16).

Table 11.1.16. Round the year vegetables and fruits production per homestead area during 2018 to 2021 at FSRD site, Sreepur, Gazipur

Space		Rabi			Kharif-1			Kharif-II			Total (Kg)		
		October- March			April-June			July-September					
		Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III
Open sunny space	Bed-1	10	10	8	3	3	7	5	6	9	18	19	24
	Bed-2	12	12	5	4	4	5	6	7	12	22	23	22
	Bed-3	14	11	6	3	3	4	7	5	10	24	19	20
	Bed-4	9	12	8	5	5	5	9	7	11	23	24	24
Roof top		0	0	5	0	0	2	0	1	3	0	1	10
Trellis		30	15	12	10	10	10	20	15	8	60	40	30
Shady Place		5	7	6	2	4	4	3	5	5	10	16	15
Marshy Land		0	0	3	0	1	1	0	0	4	0	1	8
Unproductive Tree		6	6	6	1	4	5	3	3	3	10	13	14
Fence		8	12	9	3	8	6	5	5	5	16	25	20
Backyard		3	2	2	1	1	1	1	1	2	5	4	5
House Boundary		6	6	6	3	5	5	3	5	7	12	16	18
Total (vegetables)		103	93	76	35	48	55	62	60	79	200	201	210
Fruits		32	33	26	25	31	32	30	33	24	87	97	82
Total (vegetables +fruit)		135	118	84	60	99	93	92	113	89	287	330	266

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Both vegetables production and income were increased after intervention. Most productive unit was open sunny place (87 kg farmer^{-1}) followed by trellis (43 kg farmer^{-1}) (Table 11.1.17). Minimum productive unit was roof top (4.0 kg farmer^{-1}) because farmers was not interested to use rooftop. After intervention, income from vegetables and fruits were increased about 93% and 72%, respectively per farmer then before intervention.

Picture 11.18 .Vegetables & fruits production at FSRD site, Sreepur, Gazipur

Table 11.1.17. Round the year vegetables & fruits production and income per homestead during 2018 to 2021 (Comparative data) at FSRD site, Sreepur, Gazipur

Niches	Before intervention		After intervention									
			Year I		Year II		Year III		Avg. of three years		Avg. increment over before intervention (%)	
	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production	Income
Open sunny place	40	800	87	2175	85	2125	90	2250	87	2175	118	172
Roof top	2	40	0	0	1	25	10	250	4	100	100	150
Trellis	35	700	60	1500	40	1000	30	750	43	1075	23	54
Shady place	12	240	10	250	16	400	15	375	14	350	17	46
Marshy place	2	40	6	150	1	25	8	200	5	125	150	213
Unproductive place	10	200	10	250	13	325	14	350	12	300	20	50
Fence	20	400	16	400	25	625	20	500	28	500	40	75
Backyard	3	60	5	125	4	100	5	125	5	125	67	108
House boundary	15	300	12	300	16	400	18	450	24	375	60	100
Total	132	2640	200	5000	201	5025	210	5250	204	5100	55	93
Fruit (other places)	59	2065	87	1760	97	3880	82	3280	89	3560	51	72
Total	59	2065	87	1760	97	3880	82	3280	89	3560	51	72

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Homestead vegetables production as well as consumption, distribution and selling increased after intervention. Consumption, distribution and selling of vegetables increased about 19%, 92% and 85%, respectively. After managing fruit trees, consumption, distribution and selling of fruits were also increased about 47%, 60% and 67%, respectively. Average cost of production per farmer per year was Tk. 1572 and average gross return from homestead vegetables production was Tk. 4882 (Table 11.1.18).

Table 11.1.18. Round the year vegetables & fruits production and utilization pattern before and after intervention during 2018 to 2021 at FSRD site, Sreepur, Gazipur

Description	Before Intervention		After intervention					
	Vegetables (kg)	Fruits (kg)	Vegetables (kg)			Fruits (kg)		
			Year I	Year II	Year III	Year I	Year II	Year II
Consumption	76	47	100	82	90	65	74	68
Distribution	12	5	21	22	26	9	8	7
Selling	44	7	55	96	93	13	15	7
Total production	132	59	176	200	209	87	97	82
Gross return (Tk.)	2640	1180	4410	5004	5233	3480	3880	3280
Variable cost (Tk.)	1375	379	1561	1725	1129	717	813	740
Gross Margn (Tk.)	1265	801	2849	3279	4104	2763	3068	2540

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Vegetables avg. price=20 Tk./kg, Fruits avg. price=40 Tk./kg.

BFRI Component

FSRD Site: Mokamia, Fulpur, Mymensingh

Vegetables production: Homestead areas were utilized scientifically considering time and space. After intervention, it was found that highest production (1447 kg homestead^{-1}) obtaind from open space followed by trellis (747 kg homestead^{-1}) and the lowest (342 kg homestead^{-1}) was found from roof toop. Maximum vegetables were produced during Rabi season (1134 kg homestead^{-1}) followed by Kharif-1 season (952 kg homestead^{-1}) and Kharif-2 (450 kg homestead^{-1}) season (Table 11.1.19).

Table 11.1.19. Season wise vegetables production per homestead area during 2018 to 2021 at FSRD site Mokamia, Fulpur, Mymensingh

Niches	Vegetable production in different niches per homestead (kg)			Total (Kg)
	Rabi	Kharif-1	Kharif-2	
Open space	680	517	250	1447
Trellis	321	326	100	747
Roof top	133	109	100	342
Total	1134	952	450	2536

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Afrer intervention, the vegetables production was 2536 kg per homested per year and it was only 1392 kg before intervention. After intervention, vegetables production was increased 82.18% compared to before intervention due to use of HYV seeds and management like, IPM and IPNS (Table 11.1.20).

Table 11.1.20. Round the year vegetables production before & after intervention during 2018 to 2021 at FSRD site Fulpur, Mymensingh

Niches	Vegetables Production/year/farmer (kg)		Vegetables Production Increased (%)
	Before intervention	After intervention	
Open space	743	1447	94.75
Trellis	425	747	75.76
Roof top	224	342	52.68
Total	1392	2536	82.18

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

The data of vegetables production in before intervention was taken from the baseline survey of the respective site


Picture 11.19. Vegetables production at FSRD Site: Mokamia, Fulpur,Mymensingh

The detail utilization pattern and cost-return analysis presented in Table 11.1.21. The total production of vegetables was 2538 kg homestead^{-1}. From total production sold 2026 kg and conssumtion 512 kg, homestead^{-1}. The gross return, variable cost and gross margin were Tk. 58750, Tk. 15241 and Tk. 43509, respectively. The average gross margin/farmer/year was Tk. 43509 while monthly average gross margin per farmer was Tk. 3626. It was found that the income as well as intake of vegetables increased.

Table 11.1.21. Production, cost and return analysis of vegetables in homestead during 2018 to 2021 at FSRD site Mokamia, Fulpur, Mymensing

Total Production (kg)	Total consumption (kg)	Total Sold (kg)	Gross Return (Tk.)	Total Variable cost (Tk.)	Gross Margin (Tk.)	Avg. Gross margin farmer^{-1} month^{-1} (Tk.)
2538	512	2026	58750	15241	43509	3626

11.2. Vegetables production nearby homestead

FSRD Site: Sholakundu, Faridpur (BARI)

Cropping pattern I: Tomato-Chilli/Sweet gourd

Improved cropping pattern: Tomato (BARI Tomato-18)+Lettuce (BARI Lettuce-1) - Chilli (BARI Morich-2)/Sweet gourd (BARI Misti Kumra-2) in Dragon fruit orchard

Existing cropping pattern: Tomato (Hybrid)-Chilli (Local)/Sweet gourd (Hybrid) in Dragon fruit orchard

Farmers cultivate sole Tomato but intercropping of Lettuce with BARI developed Tomato might be a good practice. During kharif II season, sweet gourd was cultivated as a relay crop with chilli. BARI varieties were used in after intervention package. Before intervention, farmers normally used local or imported hybrid varieties (Table 11.2.1) and their date of sowing was earlier than that of after intervention sowing date. BARI developed varieties were used in after intervention. Farmers Tomato variety performed better (32.00 t ha^{-1}) due to use of hybrid variety. In the improved cropping pattern, Additional 6.40 t ha^{-1} Lettuce was produced along with 26.20 t ha^{-1} Tomato (BARI Tomato-8). The yield of chilli was 6.15 t ha^{-1} and 6.36 t ha^{-1} for before and after intervention, respectively. BARI Misti Kumra-2 produced 11% higher yield than imported hybrid due

Picture 11.20. Improved Cropping pattern at FSRD site Sholakundu, Faridpur

to lower fertile flower in before intervention. Whole patter gross margin was Tk. 964430 ha^{-1} during after intervention and it was 7% higher than that of before intervention (11.2.1).

Farmers were interested to cultivate Tomato with Lettuce as intercropping technology and other crops with BARI released varieties in the next year.

Picture 11.21. Improved Cropping pattern at FSRD site Sholakundu, Faridpur

Table 11.2.1. Yield and return of vegetables production near by the homestead before and after intervention during 2019-2021 at FSRD site, Sholakundu, Faridpur.

Vegetables	Before intervention (kg)			After intervention (kg)			
	Rabi	Kharif-1	Kharif-2	Rabi		Kharif-1	Kharif-2
Crop	Tomato	Chilli	Sweet gourd	Tomato+Lettuce		Chilli	Sweet gourd
Variety	Hybrid	Local	Hybrid	BARI Tomato-18	BARI Lettuce-1	BARI Morich-2	BARI Misti Kumra-2
Total production (t ha^{-1})	32.00	6.15	10.50	26.20	6.40	6.36	11.62
Gross return (Tk.ha^{-1})	384000	738000	210000	314400	128000	763200	232400
TVC (Tk.ha^{-1})	213300	159640	60895	237630		173520	62420
Gross Margin (Tk.ha^{-1})	170700	578360	149105	204770		589680	169980
Whole pattern gross margin (Tk. ha^{-1})	898165			964430			

Output price (Tk.kg^{-1}): Tomato: 12, Lettuce: 20, Chilli: 120, Sweet gourd: 20

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Cropping pattern II: Tomato-Bitter gourd

Improved cropping pattern: Tomato (BARI Tomato-19)-Bitter gourd (BARI Korola-2)

Existing cropping pattern: Tomato (Hybrid)-Bitter gourd (Hybrid)

Before intervention, farmers normally used imported hybrid varieties for Tomato and Bitter gourd cultivation (Table 11.2.2) but BARI developed varieties named BARI Tomato-19 and BARI Korola-2 were used in after intervention. Bitter gourd was harvested up to Kharif II season.

Picture 11.22. Improved Cropping pattern at FSRD site Sholakundu, Faridpur

Farmers Tomato variety performed better (62.83 t ha^{-1}) due to use of hybrid variety. In the improved cropping pattern, BARI Tomato-19 produced 57.87 t ha^{-1} yield. The yield of Bitter gourd was 12.28 t ha^{-1} and 17.84 t ha^{-1} for before and after intervention, respectively. In hybrid Bitter gourd, plant leaf was infected with diseases. Whole patter gross margin was Tk. 927051 ha^{-1} during after intervention and it was 39% higher than that of before intervention (Table 11.2.2). Farmers were interested to cultivate vegetable crops with BARI released higher yielding varieties in the next year.

Table 11.2.2. Yield and return of vegetables production near by the homestead before and after intervention during 2019-2021 at FSRD site, Sholakundu, Faridpur

Vegetables	Before intervention (kg)			After intervention (kg)		
	Rabi	Kharif-1	Kharif-2	Rabi	Kharif-1	Kharif-2
Crop	Tomato	Bitter gourd	Bitter gourd continued	Tomato	Bitter gourd	Bitter gourd continued
Variety	Hybrid	Hybrid	--	Tomato (BARI Tomato-19)	Bitter gourd (BARI Korola-2)	Bitter gourd continued
Total production (t ha^{-1})	62.83	12.28		57.87	17.84	
Gross return (Tk.ha^{-1})	628300	552600		636680	802800	
Total variable cost (Tk.ha^{-1})	324395	187428		322995	189434	
Gross Margin (Tk.ha^{-1})	303905	365172		313685	613366	
Whole pattern gross margin (Tk.ha^{-1})	669077			927051		

Output price (Tk.kg^{-1}): Tomato: 10, Bitter gourd: 45

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Maximum yield was obtained from bottle gourd (23670 kg ha^{-1}) in rabi season and brinjal (13260 kg ha^{-1}) in kharif-2 season. Minimum yield was observed in tomato during rabi season and chilli in kharif-2 season. The highest gross margin (Tk. 205307 ha^{-1}) was obtained from rabi season followed by kharif-2 (Tk..147574 ha^{-1}). It was observed that bottle gourd and brinjal cultivation was more profitable than other rabi crops cultivation. Farmer's preferred early production of vegetables for getting higher profit (Table 11.2.3).

Table 11.2.3. Yield and economics of vegetables production near by the homestead before and after intervention during 2019- 2020 at FSRD site Tengra, Sreepur, Gazipur

Crops	Before intervention (kg ha^{-1})			After intervention (kg ha^{-1})		
	Rabi	Kharif-1	Kharif-2	Rabi	Kharif-1	Kharif-2
T. Aman	-	-	3000	-	-	-
Bottle gourd- Brinjal	-	-	-	23670	-	13260
Cauliflower - Ladies finger	-	-	-	10538	-	4870
Cabbage- Sponge gourd	-	-	-	7163	-	2750
Tomato - Chilli	-	-	-	6916	-	1200
Total production	-	-	3000	48287	-	22080
Gross return (Tk.ha^{-1})	-	-	61146	362153	-	236513
Total variable cost (Tk.ha^{-1})	-	-	56277	156846	-	88939
Gross margin (Tk.ha^{-1})	-	-	4869	205307	-	147574

Picture 11.23 . Vegetables production nearby homestead at FSRD site, Tengra, Sreepur, Gazipur

11.3. Performance of chewing type sugarcane production in the homestead

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Yield of chewing type sugarcane at homestead is shown in Table 11.3.1. Highest number of cane was harvested from Turag (575 no. year^{-1}) followed by Rongbilash (467). Considering number of cane production per seedling, maximum number of cane (7 cane per clump) produced from Turag followed by Rongbilash (5 cane per clump) and Amrita (4 cane per clump). Farmer's responses were very encouraging. Based on the result and farmers' opinion Turag and Rongbilash can be cultivated in homestead which will increase farmer's income as well as improve the nutritional status of the farm families.

Table 11.3.1. Cane yield of different chewing type sugarcane in homestead at FSRD Site Tengra, Sreepur, 2018-2020

Variety	Number of seedlings supplied		Number of canes harvested		Average no. of cane/clump		Field duration (Days)	
	Year I	Year II	Year I	Year II	Year I	Year II	Year II	Year II
Turag	60	120	475	675	8	6	255	265
Rongbilash	60	120	353	580	6	5	280	288
Amrita	60	120	236	422	4	4	277	290

* Year I= Feb.2018-Jan.2019 & Year II= Feb.20219- Jan.2020

From cost return analysis it was observed that, average highest gross return and gross margin 900 and Tk. 680, respectively per pit per year were found from Turag followed by Amrita 707 and Tk. 487 (Table 11.3.2). Performance of Rongbilash was comparatively poor.

Table 11.3.2. Cost and return of chewing type sugarcane varieties at homestead, Tengra, Sreepur, 2018-20

Variety	Yield (No of cane/pit)		TVC/pit (Tk.)		Gross return/pit (Tk.)		Gross margin/pit (Tk.)	
	Year II	Year III	Year II	Year III	Year II	Year III	Year II	Year III
Turag	48	30	220	220	1200	600	980	380
Rongbilash	34	25	220	220	680	375	440	155
Amrita	26	41	220	220	390	1025	170	805

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021
Price/cane (Tk.): Turag@25, Rongbilash@20, Amrita and China@15.

Picture 11.24. Chewing type sugarcane cultivation in homestead, area at FSRD site Tengra, Sreepur

11.4. Performance of turmeric and ginger production under fruit tree based agro forestry system near the homstead

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Turmeric yielded 21, 20 and 20 t ha^{-1}, respectively during 2018-2021. Yield of ginger was 10, 8 and 7.5 t ha^{-1}, respectively in three consecutive years. Average production of ginger and turmeric was 8.5 t ha^{-1} and 20.33 t ha^{-1}. Total cost for the production of ginger and turmeric were 2,50,000 ha-1 and Tk. 1,95,000 ha-1, respectively. Considering the gross margin, the highest average gross margin was obtained from ginger Tk. 6,00,000 ha^{-1} followed by turmeric Tk. 3, 13,333 ha^{-1} (Table 11.4.1).

Table 11.4.1. Yield and economics of ginger and turmeric production at 200 m2 area, Tengra, Sreepur, Gazipur, 2018-2 021

Crop	Yield (t ha^{-1})			Total cost (Tk. ha^{-1})			Gross return (Tk. ha^{-1})			Gross margin (Tk. ha^{-1})		
	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III	Year I	Year II	Year III
Ginger	10	8	7.5	255000	245000	250000	1000000	800000	750000	745000	555000	500000
Turmeric	21	20	20	200000	195000	190000	525000	500000	500000	325000	305000	310000

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021
Price/Kg (Tk.): Ginger@100, Turmeric@25.

Picture 11.25. Turmeric and ginger production under fruit tree based agro forestry system near the homstead at FSRD site Sreepur, Gazipur

11.5. Establishment of fruit garden at homestead and nearby homestead during 2018 to 2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Sapling/seedling distribution: Number of different quality fruits saplings were supplied to homestead and for mother garden e.g., Mango, Litchi, Dragon fruit, etc. The supplied total number of saplings of different fruits plants are shown in Table 11.5.1. Total number of supplied saplings of different fruit plants and sugarcane were 489. The saplings are in good condition and survival rate ranges from 60-100%.

Picture 11.26. Fruit saplings distribution at FSRD site, Ajoddhapur, Rangpur

Table 11.5.1. Distributed fruit and Sugarcane saplings at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

Sl. No	Types of fruits sapling	Variety	Number				Survival (%)
			Year I	Year II	Year III	Total	
1	Mango	BARI Aam-3 & 4	12	30	10	52	90
2	Litchi	BARI Litchi-3	12	5	2	19	85
3	Guava	BARI Peyara-2	12	-	2	14	100
4	Malta	BARI Malta-1	12	-	-	12	92
5	Lemon	BARI Lebu-1	12	-	-	12	100
6	Papaya	Local	36	-	108	144	92
7	Dragon fruit	BARI Dragon Fruit-1	4	60	36	100	100
8	Moringa	Year round	24	-	-	24	96
9	Sugarcane	BSRI Akh 42	12	-	-	12	67
10	Palm	Local	100	-	-	100	60
Total			236	95	158	489	60-100

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna (BARI)

To increase nutrient intake from fruits sector, it needs to increase the number of quality fruit plants in the homestead. From this view, a number of different quality fruit saplings of BARI developed and locally popular varieties were supplied to homestead e.g., Mango, Litchi, Guava, Lemon, Papaya, and Bay leaf. Total number of supplied saplings of different fruit plants speicies were 818. The saplings are in good condition and survival rate ranges from 90 - 100% (Table 11.5.2). Technical support was provited to the farmer for better management of fruit trees such as fertilization, irrigation and insect and disease control.

Picture 11.27. Fruit saplings distribution at FSRD site, Ganggarampur, Pabna

Table 11.5.2. Distributed fruits and spices saplings at FSRD site, Ganggarampur, Pabna during 2018 to 2021.

Sl. No	Types of fruits sapling	Variety	Number				Survival (%)
			Year I	Year II	Year III	Total	
1.	Mango	BARI Aam-4	12	12	0	24	100
		Langra	0	13	16	29	98
		Gopalvogue	0	24	20	44	98
		Khirsha	0	12	20	32	98
2.	Litchi	BARI Litchi-3	12	10	7	29	100
3.	Guava	BARI Peyara-2	20	30	24	74	90
4.	Sweet orange	BARI Malta-1	12	0	0	12	100
5.	Lemon	Kagij	12	0	0	12	100
6.	Papaya	Local improved	160	170	150	480	95
7.	Black paper	BARI Golmorich-1	12	24	10	46	95
8.	Bay leaf	BARI Tejpata-1	12	10	14	36	90
Total			252	305	261	818	90-100

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sholakundu, Faridpur (BARI)

Number of different quality fruits saplings were supplied to homestead e.g., Dragon, Malta, Guava, Mango, Papaya, Chuijhal and Sugarcane. Total number of supplied saplings of fruits, spices and Sugarcane were 867 and survival rate ranges from 65-100% (Table11.5.3). Technical support was provited to the farmer for better management of fruit trees such as fertilization, irrigation and insect and disease control.

Picture 11.28. Fruits sapling distribution at FSRD Site, Sholakundu, Faridpur

Table 11.5.3. Distributed fruit saplings/spices/Sugarcane at FSRD site Sholakundu, Faridpur during 2018 to 2021.

Sl.no.	Types of fruits sapling	Variety	Number				Survival (%)
			Year I	**Year II**	**Year III**	**Total**	
1	Dragon fruit	BARI Dragon fruit-1	--	60	--	60	100
2	Malta	BARI Malta-1	--	20	--	20	100
3	Guava	BARI Peyara-2	10	20	15	45	100
4	Mango	BARI Aam-4	06	--	15	21	100
5	Lemon	BARI Lebu-4	--	--	15	15	100
6	Papaya	Red lady	20	20	300	340	100
7	Ber	Kashmiri kul	--	--	15	15	100
8	Cuijahl	Local	--	50	--	50	75
9	Sugarcane	BSRI Akh 41 and 42	50	150	100	300	65
	Total		86	320	461	867	65-100

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

To increase nutrient intake from fruits sector, it needs to increase the number and quality of fruit plants in the homestead. From this view, a number of different quality fruits saplings were supplied to homestead e.g., Mango, Litchi, Guava, Sweet orange, Lemon, Papaya, Dragon fruit, Moringa, Sugarcane, Plum, Burmese grape, Aonla, Golden apple, Pomegranate, Coconut and Bay leaf. Total number of supplied saplings of different fruit plant were 632. The saplings are in good condition and survival rate ranges from 75- 100% (Table 11.5.4). Technical support was provited to the farmer for better management of fruit trees such as fertilization, irrigation and insect and disease control.

Picture 11.29. Fruit saplings distribution at FSRD site, Atia, Tangail

Table 11.5.4. Distributed fruit, spices and sugarcane saplings at FSRD site, Atia, Tangail during 2018 to 2021.

Sl. No	Types of fruits sapling	Variety	Number				Survival (%)
			Year I	Year II	Year III	Total	
01.	Mango	BARI Aam-4	12	0	06	18	84
		BARI Aam-11	0	12	04	16	100
		BARI Aam-3	0	24	10	34	100
02.	Litchi	BARI Litchi-3	12	24	06	42	83
03.	Guava	BARI Peyara-2	12	12	10	34	90
04.	Sweet orange	BARI Malta-1	12	18	12	42	95
05.	Lemon	BARI Lebu-1	12	10	12	34	100
06.	Papaya	Red Lady	36	120	50	206	80
07.	Dragon fruit	BARI Dragon Fruit-1	4	10	12	26	90
08.	Moringa	Year Round	24	10	0	34	100
09.	Sugarcane	BSRI Akh-42	12	0	0	12	100
10.	Plum	BARI Alubokhara-1	10	12	05	27	75
11.	Burmese grape	BARI Lotkan-1	0	12	12	24	100
12.	Aonla	BARI Amloki-1	0	12	05	17	91
13.	Golden apple	BARI Amra-1	0	12	10	22	83
14.	Pomegranate	BARI Dalim-2	0	10	0	10	90
15.	Coconut	Vietnami Coconut	0	12	0	12	90
16.	Bay leaf	BARI Tejpata-1	0	12	10	22	75
Total			146	322	164	632	75- 100

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur (BARI)

To increase nutrient intake from fruits sector, a good number of quality fruits saplings were supplied to homestead e.g., Mango, Guava, Papaya, Litchi, Lemon, Malta, Banana, Alubokhara, Coconut, Sugarcane etc. Spices seedlings also given for increase of spices production at homestead level. The supplied total number of saplings of different fruits, sugarcane and spices plants are shown in Table 11.5.5. Total number of supplied saplings of different fruit plants, sugarcane and spices were 1196. The saplings are in good condition and survival rate ranges from 50-100%.

Picture 11.30. Fruit saplings at FSRD Site, Tarakandi, Sherpur

Table 11.5.5. Distributed fruit saplings/spices/sugarcane at FSRD site, Tarakandi, Sherpur during 2018 to 2021.

Sl. No	Types of fruits sapling	Variety	Number				Survival (%)
			Year I	Year II	Year III	Total	
1	Mango	BARI Aam-3 & 4	24	100	112	236	100
2	Litchi	BARI Litchi-3	12	50	50	112	95
3	Guava	BARI Peyara-2	0	0	24	24	100
4	Malta	BARI Malta-1	12	100	112	224	100
5	Lemon	BARI Lebu-4	0	250	250	500	95
6	Papaya	Local	24	-	0	24	100
7	Alubokhara	BARI Alubokhara-1	0	0	24	24	100
8	Coconut	Dwarf variety	0	8	8	16	100
9	Sugarcane	BSRI Akh-42	12	-	-	12	50
10	Banana	BARI Kola-1	0	12	12	24	100
Total			84	520	592	1196	50-100

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.6. Pest management activities for increasing fruits production in homestead area during 2018 to 2021

FSRD sites of BARI

Pest management of fruit tree: Pest is the major hindrance for sufficient edible fruits production in homestead area. But very simple technology, two times spray of both insectiside and fungicide, once at just before flower blooming and once at pea size fruit stage, can help for successful fruits production in homestead area. A total of 611 fruit trees were sprayed with insectide and pesticide, where 246 fruit trees were Mango (Table 11.6.1).

Picture 11.31. Pest management at FSRD sites of BARI

Table 11.6.1. Number of fruit trees sprayed for hopper and other pest control at different FSRD sites during 2018-2021

FSRD site	Mango	Guava	Jackfruit	Litchi	Malta	Coconut	Others*	Total
Ganggarampur, Pabna	51	15	20	15	12	7	11	131
Ajoddhapur, Rangpur	62	9	9	12	12	4	19	127
Atia, Tangail	40	12	10	12	12	8	14	108
Tarakandi, Sherpur	45	10	25	11	12	13	15	131
Sholakundu, Faridpur	48	12	7	12	12	6	17	114
Total	246	58	71	62	60	38	76	611

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.7. Apparent nutrient intake and supplementation during 2020-2021 at different FSRD sites of BARI

Vegetables and fruits produced in homestead areas are the major sources of human nutrition. Apparent nutrient intake especially protein, iron, carotene, vitamin B and vitamin C by a 5 member's family from year-round vegetables and fruits consumption was estimated (Table 11.7.1). The apparent nutrient supplementation was also calculated on the basis of per head requirement and considering apparent nutrient intake from vegetables and fruits sources (Table 11.7.2). Nutrient intake was varied with different locations. Intake of nutrient was positively correlated with vegetable and fruits consumption and also with production. Among the nutrient's protein intake was increased more than other nutrients but it still needs to supplement from animal source. Iron supplementation was more in Ganggarampur, Pabna (68.96%), which is very crucial nutrient for women. Other nutrients intake and supplementation also increased remarkably especially carotene and vitamin C, which was more or less sufficiently supplemented from homestead vegetables and fruits source after program intervention and it might be due to more production and relatively more intake through motivational activities.

Table 11.7.1. Apparent nutrient consumption in a year by a family from homestead vegetables and fruits (before and after intervention) during 2020-2021.

FSRD site	Intervention	Protein (g)	Iron (mg)	Carotene (µg)	Vit-B (mg)	Vit-C (mg)
Ganggarampur, Pabna	Before	9108	18687	15227000	611	160516
	After	18036	35240	30152478	1209	317855
Ajoddhapur, Rangpur	Before	1315	2697	2197826	88	23168
	After	15493	30272	25901409	1038	273042

FSRD site	Intervention	Protein (g)	Iron (mg)	Carotene (µg)	Vit-B (mg)	Vit-C (mg)
Sholakundu, Faridpur	Before	3174	6513	5306836	213	55942
	After	15730	30737	26299406	1055	277238
Atia, Tangail	Before	1533	3145	2562960	103	27018
	After	13346	26078	22312834	895	235213
Tarakandi, Sherpur	Before	649	1332	1085489	44	11443
	After	5555	10854	9286963	372	97899

Table 11.7.2. Apparent nutrient supplementation from a homestead produced vegetables and fruits on the basis of per head per day requirement (Avg. of five member's family: male 3 and female 2) during 2020-2021.

FSRD site	Category	Year	Protein (%)	Iron (%)	Vit-A (%)	Vit-B (%)	Vit-C (%)
Ganggarampur, Pabna	Male	Before	9.07	36.56	139.06	27.90	219.88
		After	23.40	91.14	398.35	49.39	571.46
	Female	Before	9.99	36.56	139.06	33.46	219.88
		After	25.74	91.14	398.35	59.18	571.46
Ajoddhapur, Rangpur	Male	Before	5.62	22.66	86.19	17.29	136.28
		After	16.08	61.72	246.00	49.41	389.70
	Female	Before	6.19	22.66	86.19	20.74	136.28
		After	17.69	61.72	246.00	59.29	389.70
Sholakundu, Faridpur	Male	Before	3.16	12.74	48.46	9.72	76.63
		After	14.16	54.34	216.59	43.50	343.11
	Female	Before	3.48	12.74	48.46	11.66	76.63
		After	15.58	54.34	216.59	52.20	343.11
Atia, Tangail	Male	Before	1.53	6.15	23.41	4.70	37.01
		After	13.30	51.03	203.40	40.85	322.21
	Female	Before	1.68	6.15	23.41	5.63	37.01
		After	14.63	51.03	203.40	49.02	322.21
Tarakandi, Sherpur	Male	Before	0.65	2.61	9.91	1.99	15.67
		After	5.53	21.24	84.66	17.00	134.11
	Female	Before	0.71	2.61	9.91	2.39	15.67
		After	6.09	21.24	84.66	20.40	134.11

Note: Standard nutritional demand: Protein (g)- 55 (Male), 50 (Fem)., Iron (mg)- 28 (Male and Fem.), Vit A (µg)- 600 (Male and Fem)., Vit B (mg)- 1.2 (Male), 1.0 (Fem) and Vit C (mg)- 40 (Male and Fem.), Source: AIS, 2017 (Krishi Diary, 2017)

11.8. Development of mini orchard in homestead

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Total 1501 saplings of different fruit species were distributed among the farmers (Table 11.8.1). Survival rate varies according to the type of fruit saplings. It was ranged from 70% to 100%. Farmer's responses were very encouraging. Some fruits like papaya, banana started to bearing. Other fruit saplings are growing well under proper management practices.

Table 11.8.1. Distributed fruit saplings at FSRD site Sreepur, Gazipur during 2018-2021

Sl. No	Types of fruits sapling	Variety	Number				Mortality (%)
			Year I	Year II	Year III	Total	
1	Mango	BARI Aam-3	50	-	100	150	15
		Lengra	-	-	100	100	10
		Himsagor	-	-	100	100	15

Sl. No	Types of fruits sapling	Variety	Number				Mortality (%)
			Year I	Year II	Year III	Total	
2	Burmese grape	BARI Lotkan-1	-	60	-	60	25
3	Wood Apple	BARI Kodbel-1	50	-	-	50	15
4	Sharifa	Thai sharifa	50	-	-	50	30
5	Wax Jambu	BARI Wax Jambu-1	50	-	-	50	20
6	Papaya	Red lady	-	60	300	360	15
7	Banana	Local	-	60		60	10
8	Litchi	BARI Litchi-3	-	04		04	00
9	Indian Olive	Local	-	-	50	50	10
10	Guava	BARI Peyara-2	-	-	50	50	10
11	Almond	Local	-	-	185	185	15
12	Dragon	BAU Dragon Fal-2	-	-	232	232	10
Total			1501				

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.9. Drumstick plantation in homestead at FSRD Site, Tengra, Sreepur, Gazipur

A total of five hundred and sixty five drumstick branches were distributed from 2018 to 2020 among the farmers. Among the distributed drumstick branches 50, 70 and 78% were survived in the year 2018, 2019 and 2020, respectively (Table 11.9.1).

Table 11.9.1. Distribution of drumstick at FSRD site Tengra, Sreepur, Gazipur during 2018-2020

Year	Number of drumstick branches	Survivality (%)
2018	100	50
2019	165	70
2020	300	78
Total	565	Range (50-78)

11.10. Plantation of Palmyra palm at FSRD Site, Sreepur, Gazipur

A total of nine hundred and fifty palmyra seeds were sown in various places of tengra, Sreepur, gazipur from 2018 to 2020. Among the distributed palmyra seed 63% and 85% were survived in respective years (Table 11.10.1).

Table 11.10.1. Plantation of Palmyra palm at FSRD site, Tengra, Sreepur, Gazipur during 2018-2020

Year	**Number of Palmyra seed**	**Mortality (%)**
2018-2019	150	37
2019-2020	800	15
Total	950	Range (15-37)

11.11. Improved management of fruit trees during 2018-2021 at FSRD Site, Sreepur, Gazipur

Table 11.1.1 shows that treated plants gave higher yield and return than those of non-treated plants after spraying. On an average each plant produced 72.0 kg mango which was 50% higher than non-sprayed plants of the base year. Each farmer gained an extra income of Tk.1200 per plant (average). On the other hand, on an average 23 jackfruits per plant was harvested where the average production per plant was 16 in non-sprayed plant. On an average about 280 Tk. per plant income increased after spraying in jackfruit plants (Table 11.11.1).

Table 11.11.1. Effect of pesticide application on mango and jackfruit production at FSRD site, Tengra, Sreepur, Gazipur during 2018-2021 (Average of 3 years)

Fruit tree	Number of plant	Avg. Amount harvested/plant before spraying (kg or no.)	Avg. Amount harvested/plant after spraying (kg or no.)	Increase in production (Kg or no.)	Income increased Plant^{-1} (Tk.)
Mango	200	48.0 kg	72.0 kg	24	1200
Jackfruit	160	16 no.	23 no.	7	280

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021
Price of mango: Tk..50/kg, jackfruit: 40/piece

11.12. Family labor utilization pattern in homestead production system at different FSRD sites during 2018 to 2021.

BARI Component

Homestead production system gave an opportunity for women employment and empowerment. From the Table 11.12.1 it was revealed that women had a good involvement in seed/seedling preparation and planting, intercultural operation, harvesting and marketing of vegetables and fruits. It is revealed that women are coming forward and participating more in income generation system. Hard working i.e., land preparation mostly was done by the men workers. Children also helped the men and women workers in the production systems especially in non hard working areas. So, it was found that homestead gardening has created a good opportunity to utilize unused labor of women and children properly, which can help to produce more crop and to earn more money by a resource poor farm family.

Picture 11.32. Family labor utilization pattern in homestead production system at different FSRD sites of BARI

Table 11.12.1. Family labor utilization pattern for homestead vegetables and fruits production at different FSRD sites of BARI

Working area	Men (%)					Women (%)					Children (%)				
	Pab	Ran	Far	Tan	Sher	Pab	Ran	Far	Tan	Sher	Pab	Ran	Far	Tan	Sher
Land preparation	40	70	50	63	65	50	25	30	33	25	10	5	20	4	10
Seed/seedling production	25	55	40	66	30	60	40	50	34	50	15	5	10	0	20
Sowing/planting	40	35	40	54	25	55	65	40	39	55	5	0	20	7	20
Intercultural operation	10	25	30	42	45	60	65	50	54	45	30	10	20	4	10
Harvesting	10	25	20	56	20	70	60	50	42	55	20	15	30	2	25
Marketing	30	45	20	76	75	65	55	80	21	20	5	0	00	3	5
Cooking	0	0	00	0	0	100	90	100	99	85	0	10	00	1	15

Pab. = Pabna, Ran.= Rangpur, Far.= Faridpur, Tan. = Tangail, Sher. = Sherpur

BRRI Component

Contribution of male for land preparation and marketing were 80% and 90%, respectively (Table 11.12.2). On the other hand, in cooking woman contributed maximum (90%) percentage of work. But seeding, sowing, intercultural operations and harvesting both man and woman contriduted more or less same percentage of work whereas their children worked (10%) with them as a helping hand. Women specially showed interest in homestead vegetables production and willingly took part in its cultural operations.

Table 11.12.2. Family labour utilization pattern for homestead vegetables production at FSRD site Sreepur, Gazipur

Work area	Men (%)	Women (%)	Children (%)
Land preparation	80	10	10
Seed/seedling	60	40	0
Sowing/planting	40	60	0
Intercultural operations	50	40	10
Harvesting	30	60	10
Marketing	90	0	10
Cooking	0	90	10

B. Improvement of crops and cropping system

I. Improvement of cropping pattern

FSRD site: Ajoddhapur, Rangpur, BARI

11.13. Improvement of existing T. Aman-Fallow-Boro cropping pattern at FSRD site, Ajoddhapur, Rangpur during 2018 to 2020

Existing cropping pattern: T. Aman (Swarna)-Fallow-Boro (BRRI dhan28)

Improved cropping pattern: T. Aman (Binadhan-17) – Mustard (BARI Sarisha-14)-Boro (BRRI dhan28)

Cost, return and yield performance of the tested pattern (T. Aman rice -Mustard-Boro rice) against existing pattern (T. Aman rice-Fallow- Boro rice) during 2018 to 2020 is presented in Table 11.13.1 and Table 11.13.2. In 2018-2019, the rice equivalent yield (REY) was 18.53 and 10.81 t ha^{-1} with the gross margin Tk. 98588 and Tk. 31540 ha^{-1} in improved and existing cropping pattern, respectively. In 2019-2020, the rice equivalent yield (REY) was 11.30 and 6.12 t ha^{-1} with the gross margin Tk. 158740 and 59760 ha^{-1} in improved and existing cropping pattern, respectively. The MBCR in improved cropping pattern was attained 3.14 and 4.23 in 2018-2019 and 2019-2020, respectively over existing cropping pattern. The higher REY was obtained from improved cropping pattern due to use of modern variety, inclusion of extra crop Mustard and improve crop management technologies. This result is consistent with the findings of (Khan *et al.,* 2005).

Picture 11.33. Cropping pattern at FSRD site: Ajoddhapur, Rangpur

Table 11.13.1. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Ajoddhapur, Rangpur during 2018-2019

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Mustard	Boro	T. Aman	Fallow	Boro
Seed /grain Yield (t ha^{-1})	4.61	1.89	5.63	3.31	-	4.67
Straw yield (t ha^{-1})	4.8	2.67	5.78	3.7	-	5.15
Rice equivalent yield (t ha^{-1})	5.13	6.32	7.08	4.18	-	6.63
Whole pattern REY (t ha^{-1})	18.53			10.81		

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Mustard	Boro	T. Aman	Fallow	Boro
Gross return (Tk.ha^{-1})	65375	80633	90230	53350	-	84540
Total variable cost (Tk.ha^{-1})	45800	29350	62500	45100	-	61250
Gross margin (Tk.ha^{-1})	19575	51283	27730	8250	-	23290
Whole pattern gross margin (Tk.ha^{-1})	98588			31540		
MBCR	3.14					

Unit price (Tk.kg^{-1}): *Aman* rice=12.75, Boro rice=15, Rice straw =1, Mustard=41.25, Mustard stover=1.

Table 11.13.2. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Ajoddhapur Rangpur during the year of 2019-2020

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Mustard	Boro	T. Aman	Fallow	Boro
Seed /grain yield (t ha^{-1})	2.53	1.52	5.48	2.1	-	4.67
Straw yield (t ha^{-1})	3.09	2.1	4.4	1.87	-	5.15
Rice equivalent yield (t ha^{-1})	3.27	2.59	5.44	1.71	-	4.41
Whole pattern REY(t ha^{-1})	11.30			6.12		
Gross return (Tk.ha^{-1})	81790	64800	136000	42720	-	110290
Total variable cost (Tk.ha^{-1})	32000	29350	62500	32000	-	61250
Gross margin (Tk.ha^{-1})	49790	35450	73500	10720	-	49040
Whole pattern gross margin (Tk.ha^{-1})	158740			59760		
MBCR	4.23					

Unit price (Tk.kg^{-1}): *Aman* rice=25, Boro rice=20, Rice straw =6, Mustard=41.25, Mustard stover=1.

11.14. Development of alternative cropping pattern T. Aus-T. Aman-Potato/Sweet gourd at FSRD site, Ajoddhapur, Rangpur during 2018 to 2020

Existing cropping pattern:T. Aman (Swarna)-Potato (BARI Alu-8)-Boro (BRRI dhan28)

Improved cropping pattern: T. Aus (BRRI dhan48)-T. Aman (Binadhan-17)-Potato (BARI Alu-8)/Sweet gourd (BARI Hybrid Misti Kumra-1)

Crop yield and economic performances of the tested pattern (T. Aus-T. Aman-Potato/Sweet gourd) against existing pattern (T. Aman-Potato-Boro) during 2018-2020 is presented in Table 11.14.1 and Table 11.14.2. In 2018-2019, the rice equivalent yield (REY) was 51.39 and 24.98 t ha^{-1} with the whole pattern gross margin Tk. 423064 ha^{-1} and Tk. 98770 ha^{-1} in improved and existing cropping pattern, respectively. In 2019- 2020, the REY was 24.96 and 14.00 t ha^{-1} with the whole pattern gross margin Tk. 391730 and 130180 ha^{-1} in improved and existing cropping pattern, respectively. The MBCR in improved pattern was found 27.05 and 22.00 over existing pattern during 2018-2019 and 2019-2020. Use of modern variety, inclusion of extra crop T. Aus and replacing Boro with Sweet gourd including improve crop management technologies were triggered the higher REY in improved cropping pattern.

Picture 11.34. Alternative cropping pattern at FSRD site: Ajoddhapur, Rangpur

Table 11.14.1. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Ajoddhapur, Rangpur during 2018-2019.

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	T. Aus	T. Aman	Potato	Sweet gourd	T. Aman	Potato	Boro
Seed /grain yield (t ha^{-1})	4.89	4.58	28.75	35.82	3.74	25.29	5.02
Straw yield (t ha^{-1})	5.11	4.67	0	0	4.21	0	5.62
Rice equivalent yield (t ha^{-1})	6.15	5.09	18.04	22.11	4.40	13.88	6.69
Whole pattern REY (t ha^{-1})	51.39				24.98		
Gross return (Tk.ha^{-1})	78460	64851	230000	281903	56100	177030	85340
Total variable cost (Tk.ha^{-1})	40550	44600	125000	22000	42500	115950	61250
Gross margin (Tk.ha^{-1})	37910	20251	105000	259903	13600	61080	24090
Whole pattern gross margin (Tk.ha^{-1})	423064				98770		
MBCR	27.05						

Unit price (Tk.kg^{-1}): *Aman* rice=12.75, Boro rice=15, Rice straw =1, Potato=10.

Table 11.14.2. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Ajoddhapur, Rangpur during the year 2019-2020

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	T. Aus	T. Aman	Potato	Sweet gourd	T. Aman	Potato	Boro
Seed /grain Yield (t ha^{-1})	4.95	2.68	28.63	36.18	2.43	25.29	5.02
Straw yield (t ha^{-1})	5.23	2.76	0	0	2.89	0	5.62
Rice equivalent yield (t ha^{-1})	5.22	3.34	9.16	7.24	2.15	7.08	4.76
Whole pattern Rice equivalent yield (t ha^{-1})	24.96				14		
Gross return (Tk.ha^{-1})	130380	83560	229040	180900	53790	177030	119060
Total variable cost (Tk.ha^{-1})	40550	44600	125000	22000	42500	115950	61250
Gross margin (Tk.ha^{-1})	89830	38960	104040	158900	11290	61080	57810
Whole pattern gross margin (Tk.ha^{-1})	391730				130180		
MBCR	22.00						

Unit price (Tk.kg^{-1}): T. Aus=20, *Aman* rice=25, Boro rice=20, Rice straw =6, Potato=8.

FSRD Site: Ganggarampur, Pabna, BARI

11.15. Improvement of existing T. Aman-Fallow-Boro rice cropping pattern at FSRD site, Ganggarampur, Pabna during 2018-2020

Existing cropping pattern: T. Aman rice (BRRI dhan39)-Mustard (Tori-7)-Boro (Local Toba)

Improved cropping pattern: T. Aman rice (Binadhan-7)-Mustard (BARI Sarisha-17)- Boro (BRRI dhan28)

Agronomic and economic performance of improved cropping pattern against existing cropping pattern is presented in Table 11.15.1 and Table 11.15.2. In the improved pattern though Tori-7 required at least 7 days less than BARI Sarisha-17 but BARI Sarisha-17 gave higher seed yield (2.25 and 2.0 t ha^{-1}) over Tori-7 (1.05 and 1.02 t ha^{-1}) at the FSRD site, Ganggarampur, Pabna during both the year. The T. Aman variety BRRI dhan39 gave lower yield (4.5 and 4.4 t ha $^{-1}$) than the Binadhan-17 (5. 5 and 5.25 t ha $^{-1}$). Yield of Boro rice in improved pattern is also higher (5.2 and 5.3 t ha^{-1}) than the existing local Boro rice whose field duration is long too. Mustard yield in improved cropping pattern was increased by above 100%, Boro rice yield increased by 30% and T. Aman rice yield increased by 23%, respectively due to application of balance fertilizer, appropriate seedling rate and age, better management practices and also due to inclusion of modern variety. Rice equivalent yield of improved cropping pattern was 15.84 and 14.55 t ha^{-1} yr.$^{-1}$ which

was about 45 and 33% higher against existing cropping pattern (10.90 and 10.94 t ha^{-1} yr^{-1}). Higher rice equivalent yield indicates higher productivity and efficiency of the improved pattern. It was observed that improved cropping pattern produced higher gross margin Tk. 70750 and 157250 ha^{-1} which was 65% higher than existing cropping pattern in two consecutive years. The marginal benefit cost ratio (MBCR) was obtained 3.60 and 4.75 during two consecutive years which further indicated the superiority to improved cropping pattern over existing pattern.

Picture 11.35. Improved cropping pattern at FSRD Site: Ganggarampur, Pabna

Table 11.15.1. Yield and economic analysis of improved and existing cropping pattern at FSRD site, Ganggarampur, Pabna during 2018-2019

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Mustard	Boro	T. Aman	Mustard	Boro
Seed /grain Yield (t ha^{-1})	5.50	2.25	5.20	4.50	1.05	4.00
Straw yield (t ha^{-1})	6.10	2.85	5.90	5.13	1.70	4.85
Rice equivalent yield (t ha^{-1})	5.50	5.14	5.20	4.50	2.4	4.00
Whole pattern Rice equivalent yield (t ha^{-1})	15.84			10.90		
Gross return (Tk.ha^{-1})	96250	90000	91000	78750	42000	70000
Total variable cost (Tk.ha^{-1})	74500	53500	78500	73500	40500	68500
Gross margin (Tk.ha^{-1})	21750	36500	12500	5250	1500	1500
Whole pattern gross margin (Tk.ha^{-1})	70750			8250		
MBCR	3.6					

Unit price (Tk.kg^{-1}): Boro rice=17.50, T. *Aman* rice =17.50, Rice straw = 4, Mustard seed =40 and stover=1.00

Table 11.15.2. Yield and economic analysis of improved and existing cropping pattern at FSRD site, Ganggarampur, Pabna during 2019-2020.

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Mustard	Boro	T. Aman	Mustard	Boro
Seed /grain Yield (t ha^{-1})	5.25	2.00	5.30	4.40	1.02	4.50
Straw yield (t ha^{-1})	4.75	2.3	4.32	4	1	4.25
Rice equivalent yield (t ha^{-1})	5.25	4.00	5.30	4.40	2.04	4.50
Whole pattern Rice equivalent yield (t ha^{-1})	14.55			10.94		
Gross return (Tk.ha^{-1})	131250	100000	132500	110000	51000	112500
Total variable cost (Tk.ha^{-1})	74500	53500	78500	73500	40500	73500
Gross margin (Tk.ha^{-1})	56750	46500	54000	36500	10500	39000
Whole pattern gross margin(Tk.ha^{-1})	157250			86000		
MBCR	4.75					

Unit price (Tk.kg^{-1}): Boro rice=25.0 T. *Aman* rice=25.0, Rice straw = 4, Mustard seed = 50 and stover=1.00

11.16. Improvement of existing T. Aman-Lentil-Sesame cropping pattern at FSRD site, Ganggarampur, Pabna during 2018 to 2020

Existing cropping pattern: T. Aman rice (BRRI dhan39)-Lentil (BARI Masur-6)- Sesame (Local)

Improved cropping pattern: T. Aman rice (Binadhan-17)- Lentil (BARI Masur-8)- Sesame (BARI Til-4)

Agronomic and economic performance of improved cropping pattern against existing cropping pattern is presented in Table 11.16.1 and Table 11.16.2. In the improved pattern BARI Masur-8 gave higher seed yield (1.8 and 1.9 t ha^{-1}) over BARI Masur-6 (1.6 and 1.8 t ha^{-1}) at the FSRD site, Ganggarampur, Pabna during both the year. The T. Aman variety BRRI dhan39 gave lower yield (4.65 and 4.45 t ha^{-1}) than the Binadhan-17 (5. 6 and 5. 5 t ha^{-1}). Yield of BARI Til-4 in improved pattern is also higher (1.45 and 1.4 t ha^{-1}) than the existing local. Lentil yield in improved cropping pattern was increased by above 10%, T. Aman rice yield increased by 20% and Sesame yield was increased by 15% respectively due to application of balance fertilizer, appropriate seedling rate and age, better management practices and also due to inclusion of modern variety. Rice equivalent yield of improved cropping pattern was 15.57 and 14.00 t ha^{-1} $yr.^{-1}$ which was about 16 and 12% higher against existing cropping pattern (13.33 and 12.45 t $ha^{-1}yr^{-1}$). Higher rice equivalent yield indicates higher productivity and efficiency of the improved pattern. It was observed that improved cropping pattern produced higher gross margin Tk.130500 and 204500 ha^{-1} which was about 31% and 18% higher than existing cropping pattern in two consecutive years. The marginal benefit cost ratio (MBCR) was obtained 4.95 and 4.84 during two consecutive years which further indicated the superiority to improved cropping pattern over existing pattern.

Picture 11.36. Improved cropping pattern at FSRD Site: Ganggarampur, Pabna

Table 11.16.1. Yield and economic analysis of improved and existing cropping pattern at FSRD site, Ganggarampur, Pabna during 2018-2019

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Lentil	Sesame	T. Aman	Lentil	Sesame
Seed /grain Yield (t ha^{-1})	5.60	1.80	1.45	4.65	1.60	1.20
Straw yield (t ha^{-1})	5.10	1.60	2.10	4.50	1.50	1.50
Rice equivalent yield (t ha^{-1})	5.60	6.66	3.31	4.65	5.94	2.74
Whole pattern Rice equivalent yield (t ha^{-1})	15.57			13.33		
Gross return (Tk.ha^{-1})	98000	117000	58000	81375	104000	48000
Total variable cost (Tk.ha^{-1})	71500	36500	34500	70500	32500	31500
Gross margin (Tk.ha^{-1})	26500	80500	23500	10875	71500	16500
Whole pattern gross margin (Tk.ha^{-1})	130500			98875		
MBCR	4.95					

Unit price (Tk.kg^{-1}): Boro rice=17.50, T. *Aman* rice=17.50, Rice straw =4.0, Lentil seed =65.0 and stover=2.00, Mustard seed=40.0 and stover=1.00

Table 11.16.2. Yield and economic analysis of improved and existing cropping pattern at FSRD site, Ganggarampur, Pabna during 2019-20

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Lentil	Sesame	T. Aman	Lentil	Sesame
Seed /grain Yield (t ha^{-1})	5.50	1.90	1.40	4.45	1.80	1.30
Straw yield (t ha^{-1})	5.25	1.72	2.05	4.41	1.64	1.53
Rice equivalent yield (t ha^{-1})	5.50	5.7	2.8	4.45	5.4	2.6
Whole pattern Rice equivalent yield (t ha^{-1})	14.00			12.45		
Gross return (Tk.ha^{-1})	137500	142500	70000	111250	135000	65000
Total variable cost (Tk.ha^{-1})	71500	38500	35500	70500	33500	33500
Gross margin (Tk.ha^{-1})	66000	104000	34500	40750	101500	31500
Whole pattern gross margin (Tk.ha^{-1})	204500			173750		
MBCR	4.84					

Unit price (Tk.kg^{-1}): Boro rice=25.0, T. *Aman* rice=25.0, Rice straw =4.0, Lentil seed =75.0 and stover=2.00, Mustard seed=50.0 and stover=1.00

FSRD Site: Sholakundu, Faridpur (BARI)

11.17. Improvement of existing Lentil-Jute-T. Aman cropping pattern at FSRD site, Sholakundu, Faridpur during 2018 to 2020.

Existing cropping pattern: Lentil (Local)- Jute (JRO524)- T. Aman rice (BRRI dhan39)

Improved cropping pattern: Lentil (BARI Masur-8)-Jute (Rabi-1)- T. Aman rice (Binadhan-17/BRRI dhan75)

The crop yield and return of the improved and existing patterns for both the years are presented in Table 11.17.1 and Table 11.17.2. It was found that, NARS varieties were performed better than that of farmer's existing varieties. For second year (2019-20), main pat (mature Jute) and baschh pat (immature Jute) yield were included resulting higher fiber and stick yield. The MBCR of first year (2018-19) and second year (2019-20) was 2.04 and 3.26, respectively. During 2nd year, yield of product and by product was higher than that of first year resulting higher rice equivalent yield (19.68), whole pattern gross margin (Tk. 531100 ha^{-1}).

The Table 11.17.3 showed the average yield and economy of improved and existing cropping pattern for 2018-19 and 2019-20. In the improved pattern, BARI Masur-8 gave higher seed yield (1.71 t ha^{-1}) over local (0.83 t ha^{-1}) at FSRD site, Sholakundu, Faridpur. The Lentil yield in improved pattern was increased by 106% due to application of balance fertilizer, better management practices and also due to inclusion of modern variety. Rabi-1 gave higher fiber yield (2.96 t ha^{-1}) over JRO-524 (2.64 t ha^{-1}). The T. Aman yield in improved cropping pattern was increased by about 12%. The Whole pattern Rice equivalent yield was 18.66 t ha^{-1} and 14.64 t ha^{-1}, respectively. Whole pattern gross margin was Tk. 170851 ha^{-1} and Tk. 107034 ha^{-1} in improved pattern and existing pattern, respectively. The average MBCR was 2.74.

Picture 11.37. Improved cropping pattern at FSRD Site: Sholakundu, Faridpur

Farmers were interested following improved cropping pattern with BARI Masur-8 for Lentil, Rabi-1 for Jute and BRRI dhan75 for rice production. Binadhan-17 was infected with false smut during pre-mature stage of grain resulting lower yield. They stored seed for next year cultivation.

Table 11.17.1. Yield and economic analysis of improved cropping pattern and existing cropping pattern at the FSRD site, Sholakundu, Faridpur during 2018-2019

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Lentil	Jute	T. Aman	Lentil	Jute	T. Aman
Variety	BARI Masur-8	Rabi-1	Binadhan-17	Local	JRO 524	BRRI dhan39
Seed /grain/fibre yield (t ha^{-1})	1.63	2.67	4.11	0.8	2.48	4.00
Stover/straw/stick yield (t ha^{-1})	0.78	4.20	5.16	0.53	3.64	5.12
Rice equivalent yield (t ha^{-1})	5.26	7.39	4.99	2.61	7.00	4.66
Whole pattern REY (t ha^{-1})	17.64			14.26		
Gross return (Tk.ha^{-1})	91990	129412	87405	45590	122520	81520
Variable cost (Tk.ha^{-1})	45230	122680	66615	42500	107580	55460
Gross margin (Tk.ha^{-1})	46760	16732	20790	3090	14940	26060
Total Gross return (Tk.ha^{-1})	308807			249630		
Total variable cost (Tk.ha^{-1})	234525			205540		
Total gross margin (Tk.ha^{-1})	84882			44090		
MBCR	2.04					

Output price (Tk./kg). Lentil: 55.00, Stover: 3.00 rice: 17.50, rice straw: 3.00, Jute fiber: 43.75, Jute stick: 3.00

Table 11.17.2. Yield and economy of improved cropping pattern and existing cropping pattern at the FSRD site, Sholakundu during the year of 2019-2020

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Lentil	Jute (both main and *basch pat*)	T. Aman	Lentil	Jute (main pat)	T. Aman
Variety	BARI Masur-8	Rabi-1	BRRI dhan75	Local	JRO 524	BRRI dhan39
Seed /grain/fibre yield (t ha^{-1})	1.79	3.26	5.05	0.87	2.81	4.20
Stover/straw/stick yield (t ha^{-1})	0.84	5.31	6.51	0.4	4.46	5.46
Rice equivalent yield (t ha^{-1})	4.80	8.14	6.74	2.38	7.00	5.65
Whole pattern REY (t ha^{-1})	19.68			15.03		
Gross return (Tk.ha^{-1})	129500	219680	181920	64275	188975	152600
Variable cost (Tk.ha^{-1})	45398	162062	66820	38093	139650	58130
Gross margin (Tk.ha^{-1})	84102	57618	115100	26182	49325	94470
Total Gross return (Tk.ha^{-1})	531100			405850		
Total variable cost (Tk.ha^{-1})	274280			235873		
Total gross margin (Tk.ha^{-1})	256820			169977		
MBCR	3.26					

Output price (Tk.kg^{-1}). Improved: Lentil: BARI Masur-8: 70.00, Stover: 5.00 rice: 27.00, rice straw: 7.00, Jute fiber: 62.50, Jute stick: 3.00
Existing: Lentil: 72.50, Stover: 3.00 rice: 27.00, rice straw: 7.00, Jute fiber: 62.50, Jute stick: 3.00

Table 11.17.3. Average yield and economic analysis of improved cropping pattern and existing cropping pattern at the FSRD site, Sholakundu during 2018 to 2020

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Lentil	Jute	T. Aman	Lentil	Jute	T. Aman
Seed/grain/fibre yield (t ha^{-1})	1.71	2.96	4.58	0.83	2.64	4.1
Stover/straw/stick yield (t ha^{-1})	0.81	4.75	5.83	0.46	4.05	5.29
Rice equivalent yield (t ha^{-1})	5.03	7.76	5.86	2.49	7	5.155
Whole pattern REY (t ha^{-1})	18.66			14.64		

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Lentil	Jute	T. Aman	Lentil	Jute	T. Aman
Gross return (Tk.ha^{-1})	110745	174546	134662	54932	155747	117060
Variable cost (Tk...ha^{-1})	45314	142371	66717	40296	123615	56795
Gross margin (Tk.ha^{-1})	65431	37175	67945	14636	32132	60265
Total Gross return (Tk.ha^{-1})	419953			327740		
Total variable cost (Tk.ha^{-1})	254402			220706		
Total gross margin (Tk. ha^{-1})	170851			107034		
MBCR	2.74					

11.18. Improvement of existing Mustard-Jute-T. Aman cropping pattern at FSRD site, Sholakundu, Faridpur during 2018 to 2020

Existing cropping pattern: Mustard (Tori-7)-Jute (JRO524)- T. Aman rice (BRRI dhan39)

Improved cropping pattern: Mustard (BARI Sarisha-17/18)- Jute (Rabi-1)-T. Aman rice (Binadhan-17/BRRI dhan75)

The crop yield and monetary return of the improved and existing patterns for both the years are presented in Table 11.18.1 and Table 11.18.2. From those tables, it was found that, NARS developed varieties were performed better than that of farmer's existing varieties. For second year (2019-20), main pat (mature Jute) and baschh pat (immature Jute) yield were included for calculating gross return. The MBCR of first year (2018-19) and second year (2019-20) was 2.04 and 2.37, respectively. During 2nd year, yield of product and by product was higher than that of first year resulting higher rice equivalent yield (18.18), whole pattern gross margin (Tk. 214276 ha^{-1}) and MBCR (2.37). The Table 11.18.3 showed the average yield and economy of improved and existing cropping pattern for 2018-19 and 2019-20. In the improved pattern, BARI released Mustard variety gave higher seed yield (1.71 t ha^{-1}) over local (0.91 t ha^{-1}) at FSRD site, Sholakundu, Faridpur.

Picture 11.38. Improved cropping pattern at FSRD Site: Sholakundu, Faridpur

The Mustard yield in improved pattern was increased by 88% due to application of balance fertilizer, better management practices and also due to inclusion of modern variety. Rabi-1 gave higher fibre yield (3.02 t ha^{-1}) over JRO-524 (2.60 t ha^{-1}). The T. Aman yield in improved cropping pattern was increased by about 12%. The Whole pattern Rice equivalent yield was 17.34 t ha^{-1} and 13.95 t ha^{-1}, respectively. Whole pattern gross margin was Tk. 140331 ha^{-1} and Tk. 97055 ha^{-1} for improved pattern and existing pattern, respectively. The average MBCR was 2.25.

Farmers were interested following improved cropping pattern with BARI Sarisha-18 for Mustard, Rabi-1 for Jute and BRRI dhan75 for rice production. Binadhan-17 was infected with false smut during pre-mature stage of grain resulting lower yield. BARI Sarisha-18 produced higher yield than that of BARI Sarisha-17. Farmers who have more family members showed interest to harvest basch pat with main pat (Jute). They stored seed of Mustard and T. Aman for next year cultivation.

Table 11.18.1. Yield and economic analysis of improved cropping pattern and existing cropping pattern at the FSRD site, Sholakundu, Faridpur during 2018-2019

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	Jute	T. Aman	Mustard	Jute	T. Aman
Variety	BARI Sarisha-17	Rabi-1	Binadhan-17	Torri	JRO524	BRRI dhan39
Seed/grain/fibre yield (t ha^{-1})	1.65	2.73	3.94	0.90	2.36	3.85
Stover/straw/stick yield (t ha^{-1})	2.76	4.30	4.85	1.80	3.34	4.10
Rice equivalent yield (t ha^{-1})	4.17	7.56	4.77	2.42	6.64	4.55
Whole pattern Rice equivalent yield (t ha^{-1})	16.50			13.61		
Gross return (Tk.ha^{-1})	72900	132338	83500	42300	116220	79670
Variable cost (Tk.ha^{-1})	45860	113110	63383	36903	106180	54460
Gross margin (Tk.ha^{-1})	27040	19228	20117	5397	10040	25210
Total Gross return (Tk.ha^{-1})	288738			238190		
Total variable cost (Tk.ha^{-1})	222353			197543		
Total gross margin (Tk.ha^{-1})	66385			40647		
MBCR	2.04					

Output price (Tk.kg^{-1}). Mustard: 40.00, stover: 2.50, rice: 17.50, rice straw: 3.00 Jute fiber: 43.75, Jute stick: 3.00

Table 11.18.2. Yield and economic analysis of improved cropping pattern and existing cropping pattern at the FSRD site, Sholakundu, Faridpur during 2019-2020

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	Jute (both main and *basch pat*)	T. Aman	Mustard	Jute (Main pat)	T. Aman
Variety	BARI Sarisha-18	Rabi-1	BRRI dhan75	Tori	JRO 524	BRRI dhan39
Seed/grain/fibre yield (t ha^{-1})	1.77	3.32	4.97	0.91	2.84	4.12
Stover/straw/stick yield (t ha^{-1})	2.78	5.38	6.46	1.66	5.53	5.36
Rice equivalent yield (t ha^{-1})	3.26	8.28	6.64	1.70	7.08	5.51
Whole pattern REY (t ha^{-1})	18.18			14.29		
Gross return (Tk.ha^{-1})	87990	223640	179410	45930	191090	148760
Variable cost (Tk.ha^{-1})	48820	162562	65382	34210	141532	56575
Gross margin (Tk.ha^{-1})	39170	61078	114028	11720	49558	92185
Total Gross return (Tk.ha^{-1})	491040			385780		
Total variable cost (Tk.ha^{-1})	276764			232317		
Total gross margin (Tk.ha^{-1})	214276			153463		
MBCR	2.37					

Output price (Tk./kg). Improved and existing: Mustard: 45.00, Stover: 3.00 rice: 27.00, rice straw: 7.00, Jute fiber: 62.50, Jute stick: 3.00

Table 11.18.3. Average yield and economic analysis of improved cropping pattern and existing cropping pattern at the FSRD site, Sholakundu, Faridpur during 2018-2020

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	Jute	T. Aman	Mustard	Jute	T. Aman
Seed/grain/fibre yield (t ha^{-1})	1.71	3.02	4.45	0.91	2.60	3.99
Stover/straw/stick yield (t ha^{-1})	2.77	4.84	5.65	1.73	4.44	4.73
Rice equivalent yield (t ha^{-1})	3.71	7.92	5.70	2.06	6.86	5.03
Whole pattern Rice equivalent yield (t ha^{-1})	17.34			13.95		

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	Jute	T. Aman	Mustard	Jute	T. Aman
Gross return (Tk.ha^{-1})	80445	177989	131455	44115	153655	114215
Variable cost (Tk.ha^{-1})	47340	137836	64382	35556	123856	55517
Gross margin (Tk.ha^{-1})	33105	40153	67073	8559	29799	58698
Total Gross return (Tk.ha^{-1})	389889			311985		
Total variable cost (Tk.ha^{-1})	249558			214930		
Total gross margin (Tk.ha^{-1})	140331			97055		
MBCR	2.25					

FSRD site, Atia, Tangail

11.19. Development of alternative cropping pattern during 2018 to 2020.

Existing cropping pattern: Boro (BRRI dhan29)-T. Aman rice (BR11)-Mustard (BARI Sarisha-14)

Improved cropping pattern: Boro (BRRI dhan29)-T. Aman rice (BRRI dhan72)-Mustard (BARI Sarisha-14)

Agronomic and economic performances of improved cropping pattern against existing cropping pattern are presented in Table 11.19.1 and 11.19.2. In the improved cropping pattern, BARI Sarisha-14 gave seed yield 1.79 and 1.75 t ha^{-1} which was 83 and 59 % higher over the farmers' existing variety Tori-7 (0.98 and 1.10 t ha^{-1}) due to introduce high yielding variety and improved management practices in two consecutive years. BRRI dhan29 produced grain yield 6.49 and 6.56 t ha^{-1} which gave 5 and 4 % higher yield compared to existing pattern (6.19 and 6.30 t ha^{-1}) might be due to better management practices and balance fertilization. BRRI dhan72 gave higher grain yield (5.42 and 5.36 t ha^{-1}) and farmers' existing variety BR11produced lower grain yield (4.59 and 4.56 t ha^{-1}) at the FSRD site, Atia, Tangail in two successive years. T. Aman rice variety BRRI dhan72 gave higher yield by 18 and 27 % over BR11 due to better management practices, use balance fertilizer, seedling age and also inclusion of new rice variety. Rice equivalent yield of improved cropping pattern was 16.84 and 16.75 t ha^{-1} yr.$^{-1}$ which was about 25 and 22% higher against existing cropping pattern (13.50 and 13.91 t ha^{-1}yr^{-1}) due to introduction of high yielding T. Aman and Mustard variety and improved management practices. Higher rice equivalent yield indicates higher productivity and efficiency of the improved pattern. It was observed that improved cropping pattern produced higher gross margin Tk. 105335 and 102810 ha^{-1} which was 62 and 57 % higher against existing cropping pattern in two consecutive years. The marginal benefit cost ratio (MBCR) was obtained 3.60 and 4.49 which further indicated the superiority to improved cropping pattern over existing pattern.

Picture 11.39. Improved cropping pattern at FSRD Site: Atia, Tangail

Table 11.19.1. Yield and economic analysis of improved and existing cropping pattern at FSRD site, Atia, Tangail during 2018-2019

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Boro	T. Aman	Mustard	Boro	T. Aman	Mustard
Seed/grain yield (t ha^{-1})	6.49	5.42	1.79	6.19	4.59	0.98
Straw yield (t ha^{-1})	5.85	5.30	2.41	6.12	4.87	1.58

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Boro	T. Aman	Mustard	Boro	T. Aman	Mustard
Rice equivalent yield (t ha^{-1})	6.49	5.42	4.93	6.19	4.59	2.72
Whole pattern REY (t ha^{-1})	16.84			13.50		
Gross return (Tk.ha^{-1})	109050	97320	74010	105090	78590	40780
Total variable cost (Tk.ha^{-1})	77560	55805	41680	76128	51690	31700
Gross margin (Tk.ha^{-1})	31490	41515	32330	28962	26900	9080
Whole pattern gross margin (Tk.ha^{-1})	105335			64942		
MBCR	3.60					

Table 11.19.2. Yield and economic analysis of alternate and existing cropping pattern at the FSRD site Atia, Tangail during 2019-2020

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Boro	T. Aman	Mustard	Boro	T. Aman	Mustard
Seed/grain yield (t ha^{-1})	6.56	5.36	1.75	6.30	4.56	1.10
Straw yield (t ha^{-1})	5.90	5.30	2.50	5.70	4.85	1.80
Rice equivalent yield (t ha^{-1})	6.56	5.36	4.83	6.30	4.56	3.05
Whole pattern Rice equivalent yield (t ha^{-1})	16.75			13.91		
Gross return (Tk.ha^{-1})	110200	96360	72500	105900	82660	45800
Total variable cost (Tk.ha^{-1})	78650	56250	41350	77500	52500	36300
Gross margin (Tk.ha^{-1})	31550	40110	31150	28400	27600	9500
Whole pattern gross margin (Tk.ha^{-1})	102810			65500		
MBCR	4.49					

Unit price (Tk.kg^{-1}): Boro rice=15, T. *Aman* rice=16.00, Rice *straw =2, Mustard seed =40 and stover=1.00*

11.20. Development of alternative cropping pattern at FSRD site, Atia, Tangail 2018 to 2020.

Existing cropping pattern: Brinjal (Singhnath)-T. Aman rice (BR11)-Cabbage (Autumn queen)

Improved cropping pattern: Okra (BARI Dherosh-2)-T. Aman rice (BRRI dhan72)- Cabbage (Autumn queen)

Agronomic and economic performances of improved cropping pattern against existing cropping pattern are presented in Table 11.20.1 and 11.20.2. In improved cropping pattern, Cabbage gave head yield 80.55 and 85.50 t ha^{-1} which was 2.74 and 3.76% higher over the farmers' practice (78.40 and 82.40 t ha^{-1}) due to improved management practices and balance fertilization in two successive years. BARI Dherosh-2 produced fruit yield 16.15 and 16.56 t ha^{-1} and BRRI dhan72 gave higher grain yield (5.34 and 5.30 t ha^{-1}) and farmers' existing variety BR11 produced lower grain yield (4.23 and 4.53 t ha^{-1}) at the FSRD site, Atia, Tangail. T. Aman rice variety BRRI dhan72 gave higher yield by 26 and 17 % over BR11 due to better management practices, use balance fertilizer, seedling age and also inclusion of new rice variety. Rice equivalent yield of improved cropping pattern was 40.62 and 42.21 t ha^{-1} $yr.^{-1}$ which was about 27.37 and 20.22% higher against existing cropping pattern (31.89 and 35.11 t $ha^{-1}yr^{-1}$) due to introduction of high yielding T. Aman rice variety and improved management practices. Higher rice equivalent yield indicates higher productivity and efficiency of the improved pattern. It was also observed that the higher total gross margin Tk. 431160 and 465050 ha^{-1} was obtained from improved cropping pattern which was 38 and 27% higher over existing pattern in two consecutive years. The marginal benefit cost ratio (MBCR) was obtained 6.34 and 6.98 which further indicated the superiority to improved cropping pattern over existing pattern.

Picture 11.40. Improved cropping pattern at FSRD Site: Atia, Tangail

Table 11.20.1. Yield and economic analysis of improved and existing cropping pattern at FSRD site, Atia, Delduar, Tangail during 2018-2019

Observations	Improved cropping pattern			Existing cropping pattern		
Crop	Okra	T. Aman	Cabbage	Brinjal	T. Aman	Cabbage
Card/fruit/grain yield (t ha^{-1})	16.15	5.34	80.55	12.90	4.23	78.40
Straw yield (t ha^{-1})	-	5.30	-	-	4.20	-
Rice equivalent yield (t ha^{-1})	15.14	5.34	20.14	8.06	4.23	19.60
Whole pattern rice equivalent yield (t ha^{-1})	40.62			31.89		
Gross return (Tk.ha^{-1})	242250	85440	322200	129000	67680	313600
Total variable cost (Tk.ha^{-1})	83840	56570	78320	72760	49830	74120
Gross margin (Tk.ha^{-1})	158410	28870	243880	56240	17850	239480
Whole pattern gross margin (Tk.ha^{-1})	431160			297570		
MBCR	6.34					

Unit Price: Card price =Tk..4.00 kg^{-1}, Brinjal=10.00, Okra= Tk..15 kg^{-1}, T. Aman rice= Tk..16.00 kg^{-1}, Straw= Tk..2.00 $kg^{-1}$and stover=1.00

Table 11.20.2. Yield and economic analysis of improved and existing cropping pattern at FSRD site, Atia, Delduar, Tangail during 2019-2020

Observations	Improved cropping pattern			Existing cropping pattern		
Crop	Okra	T. Aman	Cabbage	Brinjal	T. Aman	Cabbage
Card/fruit/grain yield (t ha^{-1})	16.56	5.30	85.50	13.30	4.53	82.40
Straw yield (t ha^{-1})	-	5.40	-	-	4.80	-
Rice equivalent yield (t ha^{-1})	15.53	5.30	21.38	9.98	4.53	20.60
Whole pattern rice equivalent yield (t ha^{-1})	42.21			35.11		
Gross return (Tk.ha^{-1})	248400	95600	342000	159600	82080	329600
Total variable cost (Tk.ha^{-1})	84650	56750	79550	79500	51570	73450
Gross margin (Tk.ha^{-1})	163750	38850	262450	80100	30510	256150
Whole pattern gross margin (Tk.ha^{-1})	465050			366760		
MBCR	6.98					

Unit Price: Card price =Tk.4.00 kg^{-1}, Brinjal=12.00, Okra= Tk .15 kg^{-1}, T. Aman rice= Tk. 16.00 kg^{-1}, Straw= Tk.2.00 $kg^{-1}$and stover=1.00

FSRD Site: Tarakandi, Sherpur (BARI)

11.21. Development of alternative cropping pattern at FSRD site, Tarakandi, Sherpur during 2018 to 2020

Existing cropping pattern: T. Aman (Hori)-Fallow-Boro (BRRI dhan29)

Alternate cropping pattern: T. Aman (BRRI dhan49)-Potato (BARI Alu-25)-Mungbean (BARI Mung-6)-T. Aus (BRRI dhan48)

Yield and economic performance of alternate cropping pattern against existing pattern are presented in Table 11.21.1, and Table 11.21.2. In the alternate pattern, BARI Alu-25 gave tuber yield (38.7 and 27.67 t ha^{-1} at (2018-19 and 2019-20) whereas in existing cropping pattern the land remained fallow at the FSRD site, Tarakandi, Sherpur during 2018-20. Inclusion of Mungbean in the pattern increased total production as

well as improve soil health as leguminous crop. The variety Hori dhan gave higher yield than the BRRI dhan49 during two consecutive years. Boro rice variety BRRI dhan29 gave yield 5.5 t ha $^{-1}$ in existing pattern. Alternate cropping pattern gave higher REY (26.8 t ha^{-1}yr^{-1}) than existing pattern (9.21 t ha^{-1}yr^{-1}) in two consecutive years. From two years average, it was observed that the higher total gross margin Tk. 245188 ha^{-1} was obtained from alternate cropping pattern T. Aus (BRRI dhan48)-T. Aman (BRRI dhan49) -Potato (BARI Alu-25)-Mungbean (BARI Mung-6) against existing cropping pattern T. Aman (Hori dhan)-Fallow-Boro (BRRI dhan29) with Tk. 75075 ha^{-1}. The marginal benefit cost ratio (MBCR) was obtained 2.64 and 1.84 which indicated the superiority to alternate cropping pattern over existing pattern.

Picture 11.41. Improved cropping pattern at FSRD Site: Tarakandi, Sherpur

Table 11.21.1. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Tarakandi, Sherpur during 2018-2019

Observation	Alternate cropping pattern				Existing cropping pattern		
Crop	T. Aman	Potato	Mungbean	T. Aus	T. Aman	Fallow	Boro
Seed/grain yield (t ha^{-1})	3.9	38.7	1.54	4.7	4.3	-	5.5
Straw yield (t ha^{-1})	4.5	-	-	5.06	5.2	-	4.35
Rice equivalent yield (t ha^{-1})	4.16	18.97	3.08	3.78	4.47	-	5.12
Whole pattern Rice equivalent yield (t ha^{-1})	29.99				9.59		
Gross return (Tk.ha^{-1})	72750	332040	54000	66160	78300	-	89600
Total variable cost (Tk.ha^{-1})	49070	173142	31120	50000	50000	-	68350
Gross margin (Tk.ha^{-1})	23680	158898	22880	16160	28300	-	21250
Whole pattern gross margin (Tk.ha^{-1})	221618				49550		
MBCR	2.64						

Unit price (Tk.kg^{-1}): Aman rice=17.5, T. Aus rice=13.0, Boro Rice= 15.50, Hori dhan=17.0, Mungbean= 50.00, Rice straw =1.0, Potato=12.0

Table 11.21.2. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Tarakandi, Sherpur during 2019-2020

Observation	Alternate cropping pattern				Existing cropping pattern		
Crop	T. Aman	Potato	Mungbean	T. Aus	T. Aman	Fallow	Boro
Seed/grain yield (t ha^{-1})	4.08	27.67	1.08	4.87	4.5	0	5.5
Straw yield (t ha^{-1})	4.85	-	-	5.07	5.1	0	4.35
Rice equivalent yield (t ha^{-1})	4.27	13.28	2.16	3.90	4.7	0	4.13
Whole pattern Rice equivalent yield (t ha^{-1})	23.61				8.83		
Gross return (Tk.ha^{-1})	106850	332040	54000	97600	117600	0	103350
Total variable cost (Tk.ha^{-1})	55450	173142	31120	62020	52000	0	68350
Gross margin (Tk.ha^{-1})	51400	158898	22880	35580	65600	0	35000
Whole pattern gross margin (Tk.ha^{-1})	268758				100600		
MBCR	1.84						

Unit price (Tk.kg^{-1}): *Aman* rice=25, Aus=19, Boro rice=18, Rice straw =1, Potato=12, Mungbean=50.

11.22. Development of alternative cropping pattern at FSRD site, Tarakandi, Sherpur during 2018 to 2020

Existing cropping pattern: T. Aman (Hori dhan)-Fallow-Boro (BRRI dhan29)

Alternate cropping pattern: T. Aus (BRRI dhan48) - T. Aman (BRRI dhan49)-Motor shuti (BARI Motorshuti-3)-Boro (Hybrid shakka)

Yield and economic performance of alternate cropping pattern against existing pattern are presented in Table 11.22.1 and Table 11.22.2. In the alternate pattern, BARI Motorsuti-3 produced green pod yield (9.3 and 9.2 t ha^{-1} in the year 2018-19 and 2019-20) whereas in existing cropping pattern the land remains fallow. The Hori dhan (local cultivar) gave higher yield than the BRRI dhan 49 during two consecutive years. Boro rice variety Hybrid shakka gave higher average yield 6.13 t ha^{-1} in alternate cropping pattern. Alternate cropping pattern gave higher REY (29.4 t $ha^{-1}yr^{-1}$) than existing pattern (10.0 t $ha^{-1}yr^{-1}$) in two consecutive years. From two years average, it was observed that the higher total gross margin Tk. 265560 ha^{-1} was obtained from alternate cropping pattern T. Aus (BRRI dhan48)-T. Aman (BRRI dhan49)-Motor shuti (BARI Motor shuti-3)-Boro (Hybrid shakka) against existing cropping pattern T. Aman (Hori dhan)-Fallow-Boro (BRRI dhan29) with Tk. 56490 ha^{-1}. The marginal benefit cost ratio (MBCR) was obtained 2.58 and 2.39 which indicated the superiority to alternate cropping pattern over existing pattern.

Picture 11.42. Alternative cropping pattern at FSRD site, Tarakandi, Sherpur

Table 11.22.1. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Tarakandi, Sherpur during 2018-2019

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	T. Aus	T. Aman	Motorshuti	Boro	T. Aman	Fallow	Boro
Seed/grain yield (t ha^{-1})	4.0	3.41	9.3	5.9	4.2	-	5.5
Straw yield (t ha^{-1})	5.0	3.66	-	6.1	5.2	-	6.2
Rice equivalent yield (t ha^{-1})	4.54	3.81	15.08	6.08	4.65	-	5.72
Whole pattern Rice equivalent yield (t ha^{-1})	29.51				10.37		
Gross return (Tk.ha^{-1})	84000	70530	279000	112500	86000	-	105900
Total variable cost (Tk.ha^{-1})	50745	50070	81500	80500	50000	-	75600
Gross margin (Tk.ha^{-1})	33255	20460	197500	32000	36000	-	30300
Whole pattern gross margin (Tk.ha^{-1})	283215				66300		
MBCR	2.58				-		

Unit price (Tk.kg^{-1}): T Aus rice=18.50, T. Aman=18.50, Motorshuti= 30.00, Boro= 17.00, Hori dhan= 18.00, Rice straw =2.00.

Table 11.22.2. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Tarakandi, Sherpur during 2019-2020.

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	T. Aus	T. Aman	Motorshuti	Boro	T. Aman	Fallow	Boro
Seed/grain Yield (t ha^{-1})	4.75	3.38	9.2	6.37	4.1	-	5.61
Straw yield (t ha^{-1})	5.65	3.81	0	7.18	5.1	-	4.4
Rice equivalent yield (t ha^{-1})	3.85	3.60	15.77	6.05	4.39	-	5.22
Whole pattern Rice equivalent yield (t ha^{-1})	29.27				9.61		
Gross return (Tk.ha^{-1})	67400	62960	276000	105915	74800	-	91355
Total variable cost (Tk.ha^{-1})	50745	50070	81500	82056	50000	-	69475

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	T. Aus	T. Aman	Motorshuti	Boro	T. Aman	Fallow	Boro
Gross margin (Tk.ha^{-1})	16655	12890	194500	23859	24800	-	21880
Whole pattern gross margin (Tk.ha^{-1})	247904				46680		
MBCR	2.39						

Unit price (Tk.kg^{-1}): T Aus rice=13, T. Aman=17.5, Motorshuti= 30.00, Boro= 15.50, Hori dhan= 17.00, Rice straw =1.00.

FSRD Site: Tengra, Sreepur, Gazipur (BRRI)

11.23. Improvement of the existing Boro-Fallow-T. Aman cropping pattern through inclusion of oil seed and pulse crops at FSRD site Tengra, Sreepur, Gazipur (BRRI)

In 2018-19 average grain yield in improved cropping pattern of Mustard (BARI Sarisha-14)-Boro (BRRI dhan84)-T. Aman (BRRI dhan71) were recorded as 1.15, 4.82 and 4.80 t/ha, respectively with rice equivalent yield (REY) of 14.10 t/ha/year where the existing cropping pattern produced 4.31 and 4.10 t/ha yield of Boro (BRRI dhan28) and T. Aman (Swarna) with REY 9.45 t/ha/year (Table 11.23.1). In 2019-2020, average grain yield in improved cropping pattern were recorded as 1.31, 4.62 and 5.12 t/ha of Mustard, Boro and T. Aman, respectively with rice equivalent yield of 14.67 t/ha/year whereas 4.22 and 4.16 t/ha yield of Boro and T. Aman were recorded in the existing cropping pattern with REY 9.42 t/ha/year (Table 11.23.2). From the cost return analysis, it was observed that, in both years improved cropping pattern performed better than the existing cropping pattern. In 2018-19 the gross margin was higher in improved cropping pattern (Tk. 41,100 /ha) compared to the existing cropping pattern (Tk. 12,900 /ha). In 2019-20 improved cropping pattern gave the higher gross margin (Tk. 48,100 /ha) over the existing cropping pattern. The marginal benefit cost ratio (MBCR) was found 1.51 and 1.62, respectively in 2018-19 and 2019-20. Farmer's opinioned that cultivation of three crops in a year increased crop productivity.

Table 11.23.1. Yield and economic analysis of alternate and existing cropping pattern at the FSRD site Tengra, Sreepur, Gazipur during 2018-2019

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	Boro	T. Aman	Boro	Fallow	T. Aman
Seed /grain Yield (t ha^{-1})	1.15	4.82	4.80	4.31	-	4.10
Straw yield (t ha^{-1})	2.50	5.06	5.30	4.65	-	4.65
Rice equivalent yield (t ha^{-1})	3.33	5.38	5.39	4.83	-	4.62
Whole pattern Rice equivalent yield(t ha^{-1})	14.10			9.45		
Gross return (Tk.ha^{-1})	253800			170100		
Total variable cost (Tk.ha^{-1})	212700			157200		
Gross margin (Tk.ha^{-1})	41100			12900		
MBCR	1.51					

Unit price (Tk.kg^{-1}): Rice= 18, straw=2, Stover=1 and Mustard=50

Table 11.23.2. Yield and economic analysis of alternate and existing cropping pattern at the FSRD site Tengra, Sreepur, Gazipur during 2019-2020

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	Boro	T. Aman	Boro	Fallow	T. Aman
Seed /grain Yield (t ha^{-1})	1.31	4.62	5.12	4.22	-	4.16
Straw yield (t ha^{-1})	2.42	4.96	5.15	4.62	-	4.75
Rice equivalent yield (t ha^{-1})	3.77	5.17	5.69	4.73	-	4.69
Whole pattern Rice equivalent yield(t ha^{-1})	14.67			9.42		

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	Boro	T. Aman	Boro	Fallow	T. Aman
Gross return (Tk.ha^{-1})	260800			170800		
Total variable cost (Tk.ha^{-1})	212700			157200		
Gross margin (Tk.ha^{-1})	48100			13600		
MBCR	1.62					

Unit price (Tk.kg^{-1}): Rice= 18, straw=2, Stover=1 and Mustard=50

Seed yield of mustard were 1.18 and 1.22 t/ha and stover yield were 2.20 and 2.12 t/ha in two successive years, respectively. Seed yield of mungbean were 0.90 and 0.80 t/ha in two successive years. Mean seed yield of mungbean was 0.85 t/ha. Grain yield of T. Aus rice was 4.55 t/ha in 2018-19 and 4.62 t/ha in 2019-20 (Table 11.23.3 & Table 11.23.4). Mean grain and straw yield of T. Aus rice were 4.59 and 5.12 t/ha during 2018-19 and 2019-20. Grain yield of T. Aman rice was 4.70 and 4.86 t/ha in two consecutive years. Farmers' pattern gave lower yield due to imbalance use of fertilizers and poor management practices and varieties. Total productivity of four crops pattern and farmers pattern were evaluated in terms of rice equivalent yield (REY) and it was calculated from the yield of component crops. Mean REY 17.02 t/ha/year was found in four crop pattern and farmers existing pattern produced 9.59 t/ha/year rice eqivalent yields. Inclusion of mustard and mungbean in rabi season in existing cropping pattern increased REY by 78% compared to farmers practice. From the economic point of view, Mustard-Mungbean-T. Aus-T. Aman cropping pattern showed its superiority over Boro-Fallow-T. Aman (Existing pattern) cropping pattern. Mean gross return of four crops pattern was found Tk. 305560 /ha and existing pattern was Tk. 172630 /ha which was 77% higher over existing pattern. Mean variable cost was higher in four crops pattern (Tk. 242400 /ha) might be inclusion of two component crops in the pattern. The mean gross margin was significantly higher in four crops pattern (Tk. 63160 /ha). The marginal benefit cost ratio (MBCR) was found 1.59 and 1.53, which indicated the superiority of the four crops pattern over farmers' pattern. Farmer is opinioned that cultivation of four crops in a year increased crop productivity undoubtedly but it is very difficult to manage.

Picture 11.43. Improvement cropping pattern through inclusion of oil seed and pulse crops

Table 11.23.3. Yield and economic analysis of alternate and existing cropping pattern at the FSRD site Tengra, Sreepur, Gazipur during 2018-2019

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	Mustard	Mungbean	T. Aus	T. Aman	Boro	Fallow	T. Aman
Seed /grain Yield (t ha^{-1})	1.18	0.90	4.55	4.70	4.22	-	4.15
Straw yield (t ha^{-1})	2.20	-	5.17	4.75	5.15	-	4.95
Rice equivalent yield (t ha^{-1})	3.40	3.25	5.12	5.23	4.79	-	4.70
Whole pattern Rice equivalent yield (t ha^{-1})	17.0				9.49		
Gross return (Tk.ha^{-1})	306000				170820		

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	Mustard	Mungbean	T. Aus	T. Aman	Boro	Fallow	T. Aman
Total variable cost (Tk.ha^{-1})	242400				157200		
Gross margin (Tk.ha^{-1})	63600				13620		
MBCR	1.59						

Unit price (Tk.kg^{-1}): Rice= 18, Mustard=50, straw=2, Stover=1 and Mungbean= 65

Table 11.23.4. Yield and economic analysis of alternate and existing cropping pattern at the FSRD site Tengra, Sreepur, Gazipur during 2019-2020

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	Mustard	Mungbean	T. Aus	T. Aman	Boro	Fallow	T. Aman
Seed /grain Yield (t ha^{-1})	1.22	0.8	4.62	4.86	4.38	-	4.2
Straw yield (t ha^{-1})	2.12	-	5.07	5.32	5.05	-	4.87
Rice equivalent yield (t ha^{-1})	3.51	2.89	5.18	5.45	4.94	-	4.74
Whole pattern Rice equivalent yield (t ha^{-1})	17.03				9.68		
Gross return (Tk.ha^{-1})	305120				174440		
Total variable cost (Tk.ha^{-1})	242400				157200		
Gross margin (Tk. ha^{-1})	62720				17240		
MBCR	1.53						

Unit price (Tk.kg^{-1}): Rice= 18, Mustard=50, straw=2, Stover=1 and Mungbean= 65

11.24. An improved cropping pattern for highland in Madhupur Tract soil: Mustard-Mungbean-T. Aus-Black gram at FSRD site Tengra, Sreepur, Gazipur

Yield and economic performance of improved and existing cropping pattern during 2018-19 and 2019-20 are presented in Table 11.24.1 & Table 11.24.2. In 2018-19 average grain yield in improved cropping pattern of Mustard (var. BARI Sarisha-14)-Mungbean (var. BARI Mung-6)-T. Aus (BRRI dhan48)-Blackgram (var. BARI Mash-4) were recorded as 1.20, 0.83, 4.85 and 0.88 t/ha, respectively with rice equivalent yield (REY) of 14.36 t/ha/year where the existing cropping pattern Fallow-Fallow-T. Aman produced 4.37 t/ha yield of T. Aman (Swarna) with REY 4.98 t/ha/year (Table 11.24.1). In 2019-2020, average grain yield in improved cropping pattern were recorded as 1.25, 0.87, 4.78 and 0.92 t/ha of Mustard, Mungbean, T. Aus and Blackgram, respectively with rice equivalent yield of 14.65 t/ha/year whereas 4.35 t/ha yield of T. Aman were recorded in the existing cropping pattern with REY 4.83 t/ha/year (Table 11.24.2). Total productivity of four crops pattern and farmers' pattern were evaluated in terms of rice equivalent yield (REY) and it was calculated from the yield of component crops. Mean REY 14.51 t/ha/year was found in four crop pattern and farmers existing pattern produced 4.91 t/ha/year rice yields. From the cost return analysis, it was observed that, in both years improved cropping pattern performed better than the existing cropping pattern. In 2018-19 the gross margin was higher in improved cropping pattern (Tk. 67,020/ha) compared to the existing cropping pattern (Tk. 16,140 /ha). It was mainly influenced by the additional crops in the improved cropping pattern. In 2019-20 improved cropping pattern gave the higher gross margin (Tk. 72,240/ha) over the existing cropping pattern. The average REY and gross margin of the improved four crop cropping pattern was increased by 196% and 385%, respectively compared to the farmers existing cropping pattern. The marginal benefit cost ratio (MBCR) was found 1.431 and 1.51, respectively in 2018-19 and 2019-20. Farmer's opinioned that cultivation of four crops in a year increased crop productivity and income undoubtedly but it is very difficult to manage.

Table 11.24.1. Yield and economic analysis of improved and existing cropping pattern at the FSRD site Tengra, Sreepur, Gazipur during 2018-2019

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	Mustard	Mungbean	T. Aus	Blackgram	Fallow	Fallow	T. Aman
Seed /grain Yield (t ha^{-1})	1.20	0.83	4.85	0.88	-	-	4.37
Straw yield (t ha^{-1})	2.44	-	5.40	-	-	-	5.45
Rice equivalent yield (t ha^{-1})	3.47	3.0	5.45	2.44	-	-	4.98
Whole pattern Rice equivalent yield (tha^{-1})	14.36				4.98		
Gross return (Tk. ha^{-1})	258480				89640		
Total variable cost (Tk. ha^{-1})	191460				73500		
Gross margin (Tk.ha^{-1})	67020				16140		
MBCR	1.43						

Unit price (Tk.kg^{-1}): Rice= 18, Mustard=50, straw=2, Stover=1, Blackgram=50 and Mungbean= 65

Table 11.24.2. Yield and economic analysis of improved and existing cropping pattern at the FSRD site Tengra, Sreepur, Gazipur during 2019-2020

Observation	Improved cropping pattern				Existing cropping pattern		
Crop	Mustard	Mungbean	T. Aus	Blackgram	Fallow	Fallow	T. Aman
Seed /grain Yield (t ha^{-1})	1.25	0.87	4.78	0.92	-	-	4.35
Straw yield (t ha^{-1})	2.36	-	5.25	-	-	-	4.30
Rice equivalent yield (t ha^{-1})	3.59	3.14	5.36	2.56	-	-	4.83
Whole pattern Rice equivalent yield (t ha^{-1})	14.65				4.83		
Gross return (Tk. ha^{-1})	263700				86940		
Total variable cost (Tk. ha^{-1})	191460				74400		
Gross margin (Tk. ha^{-1})	72240				12540		
MBCR	1.51						

Unit price (Tk.kg^{-1}): Rice= 18, Mustard=50, straw=2, Stover=, Blackgram=50 and Mungbean= 65

Picture 11.44. Improved cropping pattern at FSRD site Tengra, Sreepur, Gazipur

II. On-farm verification trial

11.25. On-farm verification trials with modern verities of cereals, oilseed, pulses, vegetables, spices and tuber crops at different FSRD sites of BARI during 2018 to 2019.

FSRD site: Ajoddhapur, Rangpur

Different crop management, varieties used, number of farmers involved in the on-farm verification trial are given in Table 11.25.1. The results revealed that incase of Mustard, BARI Sarisha-14 (yield 1.50-1.72 t ha^{-1}) and BARI Sarisha-18 (yield 1.51-1.70 t ha^{-1}) was performed better than other varieties and farmers also choose these varieties for next year cultivation. In case of Tomato, BARI Tomato-15 and BARI Tomato-18 both performed better than local variety and farmers were selected these varieties for next year cultivation. In case of Potato, all varieties gave satisfactory yield compared to BARI Alu-8, but farmers choose the BARI Alu-25 and BARI Alu-53 due to the red skin color.

Table 11.25.1. Different operations conducted and yield of different crops under on-farm verification trial at the FSRD site Ajoddhapur, Rangpur during 2018-2019

Crop	Variety	Planting date	Harvesting date	No. of farmers	Area(dec.)	Yield(t ha^{-1})
Mustard	BARI Sarisha-14	21-28 Nov.	27-28 Feb.	6	12	1.50-1.72
	BARI Sarisha-15	21-28 Nov.	27-28 Feb.	6	12	1.40-1.52
	BARI Sarisha-18	20-30 Nov.	7-8 March	6	12	1.51-1.70
	Tori-7	21-28 Nov.	23-25 Feb.	6	12	0.95-1.06
Tomato	BARI Tomato-15	16-18 Nov.	15 Feb-09 March	3	9	76-88
	BARI Tomato-18	16-18 Nov.	15 Feb-09 March	3	9	82-86
	Local	16-18 Nov.	15 Feb-09 March	3	9	70-75
Potato	BARI Alu-8	28-30 Nov.	27 Feb-05 March	7	7	23.72
	BARI Alu-25	28-30 Nov.	27 Feb-05 March	7	7	29.12-30.96
	BARI Aul-46	28-30 Nov.	27 Feb-05 March	7	7	28.05-32.52
	BARI Aul-53	28-30 Nov.	27 Feb-05 March	7	7	29.53-31.25

FSRD site: Atia, Tangail

Different crop management, varieties used, number of farmers involved in the on-farm verification trial are given in Table 11.25.2. The results revealed that incase of Mustard, BARI Sarisha-14 (yield 1.61 t ha-^{1}) and BARI Sarisha-17 (yield 1.63 t ha^{-1}) was performed better than local varieties and farmers also choose these varieties for next year cultivation. In case of Barley, BARI Barley-6 and BARI Barley-7 both performed better than local variety and farmers selected these varieties for next year cultivation. In case of Potato, BARI Alu-41 performed better than BARI Alu-7 and BARI Alu-8.

Table 11.25.2. Different operations conducted and yield of different crops under on-farm verification trial at the FSRD site Atia, Tangail during 2018-2019.

Crop	Variety	Planting date	Harvesting date	No. of farmers	Area (dec.)	Yield (t ha^{-1})
Mustard	BARI Sarisha-14	13-20 Nov.	4-11 Feb.	5	20	1.61
	BARI Sarisha-17	13-20 Nov.	3-12 Feb.	5	20	1.63
	Tori-7	13-20 Nov.	27-31 Jan.	5	20	0.99
Barley	BARI Barley-6	22-26 Nov	17-19 March	4	15	2.05
	BARI Barley-7	22-26 Nov	17-19 March	4	15	2.11
	Local	22-26 Nov	12-16 March	4	15	1.39
Potato	BARI Alu-7	24-28 Nov.	20-26 Feb	3	10	28.77
	BARI Alu-8	24-28 Nov.	20-26 Feb	3	10	28.96
	BARI Aul-41	24-28 Nov.	20-26 Feb	3	10	32.54
Wheat	BARI Gom-30	17-20 Nov.	12-15 March	3	60	3.65
	BARI Gom-31					3.80
	BARI Gom-32					3.78
	BARI Gom-33					3.97
Onion	BARI Piaj-1	04-11 Jan	06-15 April	3	60	17.77
	BARI Piaj-4					13.25
	Local					9.58

FSRD site: Tarakandi, Sherpur

Crop management, varieties used, number of farmers involved in the on-farm verification trial are given in Table 11.25.3. The results revealed that incase of Potato, BARI Alu-41 performed better than other varieties.

Table 11.25.3. Different operations conducted and yield of Potato under on-farm verification trial at the FSRD site Tarakandi, Sherpur during 2018-2019.

Crop	Variety	Planting date	Harvesting date	No.of farmers	Area (ha)	Yield (t ha^{-1})
Potato	BARI Alu-35 BARI Alu-36 BARI Alu-37 BARI Alu-40 BARI Alu-41	27.11.2019	19.02.2020- 20.02.2020	01	0.5	40.62

III. Production program

11.26. Production program with modern varieties of cereals, oilseed, pulses, vegetables, spices and tuber crops at different FSRD sites of BARI during 2018 to 2021

FSRD site: Ajoddhapur, Rangpur

Different crop management, varieties used, number of farmers involved in the production program of Mustard, Tomato and Potato is given in Table 11.26.1.

Table 11.26.1. Different operations conducted for production program at FSRD site Ajoddhapur, Rangpur

Crop	Variety	No. of farmers	Total area (ha)	Date of sowing/ transplanting	Date of harvesting
Mustard	BARI Sarisha-14	6	1	21-28 Nov.	27-28 Feb.
	BARI Sarisha-18	2	1	20-30 Nov.	7-8 March
Tomato	BARI Tomato-15	3	0.5	16-18 Nov.	15 Feb-09 March
Potato	BARI Alu-25	7	1.4	28-30 Nov.	27 Feb.-05 March
	BARI Alu-53	5	1	30 Nov-10 Dec	04-10March

a. Production program of BARI released Mustard variety

The seed yield of Mustard variety BARI Sarisha-14 was 1.75 and 1.50 t ha^{-1} and the gross margin was calculated 44138 and Tk. 35695 ha^{-1} in 2018-19 and 2019-20, respectively (Table 11.26.1.1). BARI Sarisha-18 produced 1.59 t ha^{-1} seed yield in 2019-20 with the gross margin Tk. 40258 ha^{-1}. The average seed yield gross margin of Mustard was 1.61 t ha^{-1} and Tk. 40030 ha^{-1}, respectively.

Picture 11.45. Production program of BARI released Mustard variety at FSRD site: Ajoddhapur, Rangpur

Table 11.26.1.1. Yield of Mustard variety at FSRD site, Ajoddhapur, Rangpur during 2018 to 2021

Year	Variety	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Gross return (Tk.ha^{-1})			Cost of production (Tk.ha^{-1})	Gross margin (Tk..ha^{-1})
				Grain	Straw	Total		
2018-19	BARI Sarisha-14	1.75	1.9	72188	1900	74088	29950	44138
2019-20	BARI Sarisha-14	1.50	1.82	61875	1820	63695	28000	35695
2019-20	BARI Sarisha-18	1.59	2.67	65588	2670	68258	28000	40258
2020-21	BARI Sarisha-14	1.60	2.12	66551	2130	68681	28650	40031
Average	**-**	**1.61**	**2.13**	**66550**	**2130**	**68680**	**28650**	**40030**

Market price of output (Tk.Kg^{-1}): Seed=41.25 and Stover=1.00.

b. Production program of BARI released Tomato varieties

BARI Tomato-15 and BARI Tomato-18 seedlings were produced and supplied by the LSP to other farmers, who bought it at reduced price. The fruit yield of BARI Tomato-15 was 88.00 and 76.54 t ha^{-1} and gross margin was calculated Tk. 662000 and 560400 ha^{-1} during the year of 2018-19 and 2019-20, respectively (Table 11.26.1.2). BARI Tomato-18 produced 82.32 t ha^{-1} fruit yield with gross margin Tk. 618200 ha^{-1} in 2019-20. The average fruit yield and gross margin were 82.29 t ha^{-1} and Tk. 613533 ha^{-1}, respectively.

Picture 11.46 Production program of BARI released Tomato varieties at FSRD site, Ajoddhapur, Rangpur

Table 11.26.1.2. Yield of Tomato variety at FSRD site, Ajoddhapur, Rangpur during 2018 to 2021

Year	Variety	Fruit yield (t ha^{-1})	Gross return (Tk.ha^{-1})	Cost of production (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
2018-19	BARI Tomato-15	88.00	880000	218000	662000
2019-20	BARI Tomato-15	76.54	765400	205000	560400
2019-20	BARI Tomato-18	82.32	823200	205000	618200
2020-21	BARI Tomato-15	82.28	822868	209335	613532
Average	-	82.29	822867	209333	613533

Market price of output (Tk.kg^{-1}): Tomato=10.

c. Production program of BARI released Potato varieties

BARI Alu-53 and BARI Alu-25 were produced during 2018-19, 2019-20 and 2020-21. The tuber yield of BARI Alu-53 and BARI Alu-25 were 29.62 and 30.12 t ha^{-1} and gross margin was calculated Tk. 170200 and 174200 ha^{-1} in 2018-19 and 2019-20, respectively (Table 11.26.1.3). The average tuber yield and gross margin were 29.87 t ha^{-1} and Tk. 172200 ha^{-1}, respectively.

Picture 11.47. Production program of BARI released Potato varieties at FSRD site, Ajoddhapur, Rangpur

Table 11.26.1.3. Yield of Potato variety at FSRD site, Ajoddhapur, Rangpur during 2018 to 2021

Year	Variety	Tuber yield (t ha^{-1})	Gross return (Tk.ha^{-1})	Cost of production (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
2018-19	BARI Alu-53	29.62	296200	126000	170200
2019-20	BARI Alu-25	30.12	301200	127000	174200
2020-21	BARI Alu-53	29.86	298699	126500	172199
Average	-	29.87	298700	126500	172200

Market price of output (Tk.kg^{-1}): Potato=10.

FSRD site: Ganggarampur, Pabna

The production program on Wheat, Garlic, Onion, Mustard, Lentil, Sesame and Turmeric was conducted at FSRD site, Ganggarampur, Pabna during the years of 2018 to 2021. The number of cooperator farmers, area coverage, date of sowing/planting and date of harvesting is presented in Table 11.26.2. The variety BARI Gom-28, BARI Rashun-2 and BARI Piaj-2, BARI Sarisha-17, BARI Masur-8 and BARI Halud-4 was used in the production program. The average yield of Wheat was 4.12 t ha^{-1} with gross margin of Tk. 24000

ha^{-1}. The average yield of Garlic was 8.75 t ha^{-1} with gross margin of Tk. 96250 ha^{-1}. The average yield of Onion was 12.50 t ha^{-1} with gross margin of Tk. 6500 ha^{-1}. (Table 11.26.2.1). The production program of Mustard (var. BARI Sarisha-17), Lentil (var. BARI Masur-8) and Turmeric (var. BARI Halud-4) was conducted during 2019-20 and continuing at rabi season of 2021. The average seed yield of Mustard was 1.95 t ha^{-1} with gross margin of Tk. 42062 ha^{-1} (Table 11.26.2.2). The average seed yield of Lentil was 1.58 t ha^{-1} with gross margin of Tk. 71500 ha^{-1} (Table 11.26.2.3). The average rhizome yield of Turmeric was 14.50 t ha^{-1} with gross margin of Tk. 119750 ha^{-1} (Table 11.26.2.4). The production program of Sesame (var. BARI Til -4) was conducted during 2019-20. The average seed yield of Sesame was 1.5 t ha^{-1} with gross margin of Tk. 38700 ha^{-1} (Table 11.26.2.5).

Picture 11.48. Production program of FSRD site: Ganggarampur, Pabna

Table 11.26.2. Different operations conducted for production program at FSRD site, Ganggarampur, Pabna during 2018 to 2021

Crop	Variety	No. of farmers	Total area (ha)	Date of sowing/ planting	Date of harvesting
Wheat	BARI Gom-28	2	0.5	20-26 Nov	26-28 Mar
Garlic	BARI Rashun-2	2	0.5	25-27 Nov	15-17 Mar
Onion	BARI Piaj -2	1	0.2	22-25 Dec	25-30 Mar
Mustard	BARI Sarisha-17	95	20	25-29 Nov	03-7 Mar
Lentil	BARI Masur-8	30	7	02-6 Dec	15-20 Mar
Sesame	BARI Til-4	12	2.5	15-20 March	01-5 June
Turmeric	BARI Halud-4	3	0.2	22-24 May	28-30 Dec

Table 11.26.2.1. Performance of Wheat, Garlic and Onion at FSRD site, Ganggarampur, Pabna during 2018-2019

Crop	Variety	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Cost of Production (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
Wheat	BARI Gom-28	4.12	4.45	82500	58500	24000
Garlic	BARI Rashun-2	8.75	-	218750	122500	96250
Onion	BARI Piaj -2	12.50	-	187500	122500	6500

Unit Price (Tk.Kg^{-1}): Wheatgrain = 20, Garlic = 25, Onion= 15

Table 11.26.2.2. Performance of Mustard at FSRD site, Ganggarampur, Pabna during 2019-2021

Year	Variety	Seed yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Cost of Production (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
Feb. 2019 to Jan 2020	BARI Sarisha-17	1.95	95062	53000	42062
Feb. 2020 to Feb. 2021	BARI Sarisha-17	1.94	95050	53050	42000

Unit Price: Mustard = 45

Table 11.26.2.3. Performance of Lentil at FSRD site, Ganggarampur, Pabna during 2019-2021

Year	Variety	Yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Cost of Production (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
Feb. 2019 to Jan 2020	BARI Masur-8	1.58	105000	33500	71500
Feb. 2020 to March. 2021	BARI Masur-8	1.59	105050	33500	71550

Unit Price: Lentil= Tk.70/ kg

Table 11.26.2.4. Performance of Turmeric at FSRD site, Ganggarampur, Pabna during 2019-2021.

Year	Variety	Yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Cost of Production (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
Feb. 2019 to Jan 2020	BARI Halud-4	14.50	290000	170250	119750
Feb. 2020 to Jan. 2021	BARI Halud-4	14.52	290200	170250	119950

Unit Price: Turmeric=20 $Tk.kg^{-1}$.

Table 11.26.2.5. Performance of Sesame at FSRD site, Ganggarampur, Pabna during 2019-2020.

Crop	Variety	Grain yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total variable cost (Tk.ha^{-1})	Gross margin (Tk. ha^{-1})
Sesame	BARI Til-4	1.5	77000	38300	38700

FSRD Site: Sholakundu, Faridpur

Different BARI released 15 crop varieties were used for conduction production program during the years of 2018 to 2021. A total of 51 farmer's field including 4.7 ha of land were used (Table 11.26.3).

Table 11.26.3. Production program conducted during 2018 to 2021 at FSRD site Sholakundu, Faridpur

Crop	Variety	No. of farmers	Total area (ha)	Date of sowing/ transplanting	Date of harvesting
Mustard	BARI Sarisha-14	3	0.24	8-15 Nov 18	6-12 Feb 19
	BARI Sarisha-18	3	0.3	30 Nov. -3 Dec. 19	9-11 Mar. 2020
Wheat	BARI Gom-28	4	0.4	30 Nov. -2 Dec. 18	24-25 Mar 19
	BARI Gom-33	3	0.4	30 Nov. -8 Dec. 19	19-27 Mar 20
Mungbean	BARI Mung-6	2	0.16	5 Mar 19	12-27 May 19 (2 picking)
	BARI Mung-8	3	0.24	1-2 March 2020	9-10 May 2020 (1 picking)
Sesame	BARI Til-4	3	0.24	8-12 Mar 19	1-3 Jun 19
	BARI Til-4	4	0.25	19-25 March20	15-22 June,20
Lentil	BARI Masur-8	3	0.3	28 Nov.-3 Dec. 19	20-22 Mar 2020
	BARI Masur-8	4	0.25	19 Nov-3 Dec 20	23-26 Mar 2021
Onion	BARI Piaj-1	3	0.3	4-14 Jan 2020	24-31 Mar 2020
	BARI Piaj-4	3	0.3	1-10 Jan 20	24-31 Mar 2020
	BARI Piaj-1	4	0.5	30 Dec 20-10 Jan 21	26-31 Mar 2021
	BARI Piaj-4	4	0.5	30 Dec 20-10 Jan 21	27-31 Mar 2021
Bottle gourd	Hybrid	1	0.06	25 Jul 20	25 Sep-20 Nov 20
Summer Tomato	BARI Hybrid Tomato-11	1	0.012	16 Aug 20	7-31 Oct 20
Black gram	BARI Mash-3	2	0.2	17 Sep 20	3 Dec 20
Intercropping of Radish+Onion bulb+Red amaranth with Sugarcane	Radish (BARI Mula-1), Onion (BARI Piaj -1), Red amaranth (BARI Lalshak-1), Sugarcane (Gendari local)	1	0.06	Sugarcane: 28 Oct 19 Radish+Onion+red amaranth: 1 Nov 2019	Sugarcane: 5-18 Oct 20 Radish: 1-5 Jan 2020 Onion: 5-10 Jan 2020 Red amaranth: 4-5 Dec 2019

Mustard: BARI Sarisha-14 and 18 were used during 2018-19 and 2019-20, respectively. The seed was sown on 8-15 Nov 2018 (BARI Sarisha-14) and 30 Nov. -3 Dec. 2019 (BARI Sarisha-18). A total of 0.54 ha of land with six farmers were selected. The fertilizers were applied @ 120-36-40-15-2-1 kg of N-P-K-S-Zn-B ha^{-1}. The crop was harvested on 6-12 Feb 2019 and 9-11 Mar 2020. The yield of BARI Sarisha-14 was 1.76 t ha^{-1} with gross margin Tk. 27070 ha^{-1} (Table 11.26.3.1). BARI Sarisha-18 produced 1.71 t ha^{-1} seed yield with 2.67 t ha^{-1} stover yield. Gross margin of BARI Sarisha-18 was 35% higher than that of BARI Sarisha-14. Average seed yield, gross return and gross margin was 1.74 t ha^{-1}, Tk. 82080 ha^{-1} and Tk. 31843 ha^{-1}.

Picture 11.49. Production program of BARI Sarisha-14 and 18 at FSRD Site: Sholakundu, Faridpur

Farmers opined positive to the new variety BARI Sarisha-14 and 18 for its higher seed yield and negligible pest infestation. Too much amount of seed has been stored by the farmers for growing in the next year. Shattering tendency of seed in BARI Sarisha-18 was observed. Plant height was higher than that of BARI Sarisha-14 resulting lodging.

Table 11.26.3.1. Yield, cost and return of BARI released mustard variety at FSRD site Sholakundu, Faridpur during 2018 to 2020

.Year	Variety	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2018-19	BARI Sarisha-14	1.76	2.10	79200	52130	27070
2019-20	BARI Sarisha-18	1.71	2.67	84960	48345	36615
Average	--	1.74	2.39	82080	50237	31843

Average market price of output (Tk.kg^{-1}): Seed: 43.75, Stover: 2.55

Wheat: BARI Gom-28 and BARI Gom-33 were used during 2018-19 and 2019-20, respectively. The seed was sown on 30 Nov-2 Dec 2018 (BARI Gom-28) and 30 Nov. -8 Dec. 2019 (BARI Gom-33). A total of 0.80 ha of land with seven farmers were selected. The fertilizers were applied @ 160-30-60-15-3-1 kg of N-P-K-S-Zn-B ha^{-1}. Two-third of N and full amount of P, K, S, Zn and B were applied as basal during final land preparation. The remaining one-third of N was applied at 20-25 DAS. The crop was irrigated twice (20-25 and 55-65 DAS). Nativo was sprayed at 55-60 DAS and 70-75 DAS. The crop was harvested during 24-25 March 2019 and 19 to 27 March 2020. The grain yield of BARI Gom-28 was 3.81 t ha^{-1}. Gross margin was calculated Tk. 26542 ha^{-1} (Table 11.26.3.2). BARI Gom-33 produced 3.95 t ha^{-1} grain yield Gross margin of BARI Gom-33 was 7% higher than that of BARI Gom-28. Average grain yield, gross return and gross margin was 3.88 t ha^{-1}, Tk. 88287 ha^{-1} and Tk. 27474 ha^{-1}.

Farmers' opined that grain color of BARI Gom-33 was attractive and shiny. Plants remain greenish even at the time of mature stage resulting lower lodging. Farmers are happy with that cultivar due to higher yield and blast resistant over their existing varieties.

Table 11.26.3.2. Grain yield, cost and return of Wheat at FSRD site Sholakundu, Faridpur during the 2018 to 2020

Year	Variety	Yield (t ha^{-1})	GR (Tk. ha^{-1})	TVC (Tk. ha^{-1})	GM (Tk. ha^{-1})
2018-19	BARI Gom-28	3.81	85725	59183	26542
2019-20	BARI Gom-33	3.95	90850	62444	28406
Average	--	3.88	88287	60813	27474

Average market price of output (Tk..kg^{-1}): Seed: 22.75

Mungbean: BARI Mung-6 and BARI Mung-8 were used during the years of 2019 and 2020, respectively. The seed was sown on 5 March 2019 (BARI Mung-6) and 1-2 March 2020 (BARI Mung-8). A total of 0.40 ha of land with five farmers were selected. The fertilizers were applied @ 24-32-24-18-2-1 kg of N-P-K-S-Zn-B ha^{-1}. All fertilizer was applied as basal during final land preparation. One irrigation (29-30

DAS) and one hand weeding (26-28 DAS) were done. The crop was harvested during 12-27 May 2019 with 2 picking and 9 to 10 May 2020 (one picking). The seed yield of BARI Mung-6 was 0.76 t ha^{-1} with gross margin in Tk.9988 ha^{-1} (Table 11.26.3.3). BARI Mung-8 produced 0.69 t ha^{-1} seed yield. Gross margin of BARI Mung-8 was 137% higher than that of BARI Mung-6. During 2nd year, seed price was higher @ Tk. 17.50 kg^{-1} than first year and one picking was happened. Average seed yield, gross return and gross margin was 0.73 t ha^{-1}, Tk. 51350 ha^{-1} and Tk. 16838 ha^{-1}.

Farmers were happy for getting higher price from BARI Mung-8 because of yellow seed coat color over BARI Mung-6.

Table 11.26.3.3. Seed yield, cost and return of Mungbean at FSRD site Sholakundu, Faridpur during 2019 to 2020

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2019	BARI Mung-6	0.76	47500	37512	9988
2020	BARI Mung-8	0.69	55200	31512	23688
Average	--	0.73	51350	34512	16838

Average market price of output (Tk.kg^{-1}): Seed: 71.75

Sesame: A production program was conducted with BARI Til-4 at the FSRD site, Faridpur during Kharif I, 2019 and 2020. A total of 0.49 ha of land with seven farmers were selected. The seed was sown on 8-12 March 2019 and 19-25 March 2020. The fertilizers were applied @ 100-40-40-20-3-3 kg of N-P-K-S-Zn-B ha^{-1}. Half N and all amount of P, K, S, Zn and B was applied as basal during final land preparation. Rest N was applied as top dress at 25-27 DAS under moist soil condition and mixed thoroughly with the soil as soon as possible for better utilization. Irrigation and hand weeding were done when as necessary. The crop was harvested during 1-3 Jun 2019 and 15-22 Jun 2020. The seed yield obtained from BARI Til-4 was 1.83 tha^{-1} and 1.34 tha^{-1} during 2019 and 2020, respectively (Table 11.26.3.4). Gross margin of BARI Til-4 during 2nd year was Tk. 46093 ha^{-1}, which was lower than that of 1st year gross margin (Tk. 85255 ha^{-1}). This was due to lower seed yield during 2nd year for heavy rainfall at seed formation stage. Average seed yield, gross return and gross margin was 1.59 t ha^{-1}, Tk. 105607 ha^{-1} and Tk. 65674 ha^{-1}.

Farmers were happy for getting higher yield from BARI Til-4 with higher price. They were disappointed for getting poor yield due to unexpected heavy rainfall was occurred during seed formation stage. Almost all plant was harvested before maturity of seed. Farmers demanded black colored seed variety of Sesame due to Tk. 25 kg^{-1} more selling price of black seed than BARI variety (reddish colored seed)

Table 11.26.3.4. Seed yield, cost and return of Sesame at FSRD site Sholakundu, Faridpur during 2019-2020

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2019	BARI Til-4	1.83	123630	38375	85255
2020	BARI Til-4	1.34	87585	41492	46093
Average	--	1.59	105607	39933	65674

Average market price of output (Tk.kg^{-1}): Seed: 66.00

Lentil: A production program with BARI Masur-8 was conducted during the rabi 2019-20 and 2020-21. A total of seven cooperator farmers were considered. A total of 0.55 ha of land was used. The seed was sown on 28 Nov. to 3 Dec. 2019 and 19 Nov. to 3 Dec. 2020. The crop was fertilized with 28-24-14-9-2-1 kg of N-P-K-S-Zn-B ha^{-1} in the form of urea, TSP, MoP, gypsum, zinc sulphate mono hydrate, boric acid, respectively. All fertilizers were applied as basal. Provex and knowin (carbendazim) were applied at 22-25 DAS. Amistar top

Picture 11.50. Production program of lentil at FSRD Site: Sholakundu, Faridpur

(1 ml litre^{-1}) was applied at 70-75 DAS as preventive measure against Stemphyllium blight disease. BARI Masur-8 was harvested during 20-22 March 2020. The seed yield obtained from BARI Masur-8 was 1.76 t ha^{-1} (Table 11.26.3.5). The gross return and gross margin of BARI Masur-8 was Tk. 127600 ha^{-1} and Tk. 84370 ha^{-1}. Farmers stored different amount of seeds.

Farmers showed interest to BARI Masur-8 variety because of its higher yield potentiality and enriched iron and zinc. A good number of seed for BARI Masur-8 has been stored by the farmers for growing in the next year.

Table 11.26.3.5. Seed yield, cost and return of Lentil at FSRD site Sholakundu, Faridpur during 2019-20 and 2020-21

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2019-20	BARI Masur-8	1.76	127600	43230	84370
2020 -21	BARI Masur-8	1.76	127600	43230	84370
Average	--	1.76	127600	43230	84370

Average market price of output (Tk.kg^{-1}): Seed: 70.00

Onion: A production program of BARI Piaj-1 and BARI Piaj-4 was conducted at the FSRD site, Faridpur during the rabi 2019-20 and 2020-21. The program was conducted in about 0.6 ha of land. A total of six farmers were selected. Seedling was transplanted on 1-14 Jan 2020 and for second year, seedling will be transplanted on 30 Dec 2020 to 10 Jan 2021 both the varieties. The crop was fertilized with 140-60-60-30-3-1.5 kg of N-P-K-S-Zn and B ha^{-1} in the form of urea, TSP, MoP, gypsum, zinc sulphate mono hydrate and boric acid, respectively. All of P, S, Zn and B, and half of N and K was applied as basal during final land preparation. Remaining N and K was applied in two equal splits at 25-30 DAT and 50-55 DAT under moist soil condition and mixed thoroughly with the soil. Pesticides named Rovral, Ridomil, Amister top, Confidor, karate were sprayed. Onion varieties were harvested during 24-31 March 2020 (Table 11.26.3.6). The bulb yield of BARI Piaj-4 (16.22 t ha^{-1}) was 38% higher than that of BARI Piaj-1 (11.76 t ha^{-1}). Gross margin of BARI Piaj-1 and BARI Piaj-4 were Tk. 260335 ha^{-1} and Tk. 368925 ha^{-1}, respectively.

Picture 11.51. Production program of onion at FSRD Site: Sholakundu, Faridpu

Farmers opined positively to the BARI Piaz-4 for its higher bulb yield. Next cropping season, they will cultivate BARI Piaz-4 variety covering large area.

Table 11.26.3.6. Bulb yield, cost and return of Onion at FSRD site Sholakundu, Faridpur during 2019-20 to 2020-21

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2019-20	BARI Piaj -1	11.76	411600	151265	260335
	BARI Piaj -4	16.22	527150	158225	368925
2020-21	BARI Piaj -1	11.76	411600	151265	260335
	BARI Piaj -4	16.22	527150	158225	368925
Average	BARI Piaj -1	11.76	411600	151265	260335
	BARI Piaj -4	16.22	527150	158225	368925

Market price of output (Tk.kg^{-1}): Bulb: 35.00 (BARI Piaz-1), 32.50 (BARI Piaz-7)

Bottle gourd: A production program with imported hybrid bottle gourd was conducted during the Kharif II 2020. A total of 0.06 ha of land was used in one farmer's field. The seedling was transplanted on 25 July 2020. The crop was fertilized with 80-45-87-25-4-2-5000 kg of N-P-K-S-Zn -B and cowdung ha^{-1}.

Full amount of cowdung, P, S, Zn, B and 1/3rd of K was applied during pit preparation at least 7 days before transplanting. N and the remaining K were applied in 4 equal installments at 20, 40, 60 and 80 days after transplanting. Irrigation, plant protection measures and other intercultural operations were done as and when necessary. The Bottle gourd was harvested during 25 Sep to 20 Nov 2020. Fruit yield of Hybrid Bottle gourd was 13.60 t ha^{-1}. The gross return and gross margin were Tk. 231200 ha^{-1} and Tk. 123200 ha^{-1}, respectively (Table 11.26.3.7). Farmers were satisfied with Hybrid variety due to its higher yield, market price and taste.

Picture 11.52. Production program of Bottle gourd at FSRD Site: Sholakundu, Faridpur

Table 11.26.3.7. Fruit yield, cost and return of Bottle gourd at FSRD site Sholakundu, Faridpur during the year of 2020

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2020	Hybrid	13.60	231200	108000	123200

Market price of output (Tk..kg^{-1}): Fruit: 17.00

Summer Tomato: A production program with BARI Hybrid Tomato-11 was conducted during the kharif II 2020. A total of 0.012 ha of land was used in one farmer's field. The seedling was transplanted on 16 August 2020. The fertilizer was applied @ 104, 45, 64, 24, 2.7 and 1.3 kg ha^{-1} as N, P, K, S, Zn and B, respectively. 2 t ha^{-1} vermicompost was also applied. Four times irrigation was applied at 1, 15, 44 and 74 DAP. Half of organic fertilizer and all of P, S, Zn and B was applied as basal during final land preparation. Remaining organic manure was applied in pits before planting of seedling. One third of N was applied at 15 DAP as ring method. Rest one third N and half of K Soil was applied at 44 and 74 DAP, respectively as ring method. No weeding was done because of providing polymulch. Two times fungicides with Autostin and Ridomilgold at 10 and 20 DAP, respectively. Bio control measures like sex pheromone trap and yellow skicky was applied at 37-39 DAP. Two times insecticides with Imitaf and Pegasus was applied at 28 and 38 DAP, respectively. The Tomato was harvested during 7-31 Oct 2020. Fruit yield of BARI Hybrid Tomato-11 was 5.50 t ha^{-1}. The gross return and gross margin were Tk. 605000 ha^{-1} and Tk. 159460 ha^{-1}, respectively (Table 11.26.3.8). Farmers' opined that it was first time cultivation with BARI Hybrid Tomato-11 to their life. Farmers became interested to cultivate BARI Hybrid Tomato-11 for its lucrative shape and higher market price.

Picture 11.53. Production program of Summer Tomato at FSRD Site: Sholakundu, Faridpur

Table 11.26.3.8. Fruit yield, cost and return of summer Tomato at FSRD site Sholakundu, Faridpur during the year of 2020

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC(Tk.ha^{-1})	GM (Tk.ha^{-1})
2020	BARI Hybrid Tomato-11	5.50	605000	445540	159460

Market price of output (Tk.kg^{-1}): Fruit: 110.00

Blackgram: A production program without ploughing (zero tillage) BARI Mash-3 was done at the FSRD site, Faridpur during the kharif II 2020. A total of 02 cooperator farmers were selected having a total of 0.2 ha of land. Seeds were sown during 17 September, 2020. All fertilizers were applied @ 20-18-20-10-1.8 N-P-K-S-B kg ha^{-1} before seed sowing. BARI Mash-3 was harvested during 3rd December 2020. The seed yield obtained from BARI Mash-3 was 1.12 t ha^{-1} (Table 11.26.3.9). The gross return and gross margin of BARI Mash-3 was Tk. 67200 ha^{-1} and Tk. 43050 ha^{-1}.

Farmers showed interest to BARI Mash-3 for its lower cost of production and higher market value. A good amount of seed of BARI Mash-3 has been stored by the farmers for growing in the next year.

Picture 11.54. Production program of Blackgram at FSRD Site: Sholakundu Faridpur

Table 11.26.3.9. Seed yield, cost and return of black gram at FSRD site Sholakundu, Faridpur during the year of 2020

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2020	BARI Mash-3	1.12	67200	24150	43050

Market price of output (Tk.kg^{-1}): Seed: 60.00

Inter cropping of Radish+Onion bulb+Red amaranth with chewing type Sugarcane: A production program of intercropping of Radish+Onion bulb+Red amaranth with chewing type Sugarcane was conducted during 2019-20. A total of 0.06 ha of land was used in one farmer's field. The Sugarcane sett was planted on 28 Oct. 2019. Radish, Onion bulb and Red amaranth were sown on 1 Nov. 2019. The Sugarcane crop was fertilized with 230-100-750-45-4-2 kg ha^{-1} N-P-K-S-Zn-B. For Onion sett bulb and Radish production, 50% of recommended dose of Onion (140-60-60-30-3-1.5 kg ha^{-1} N-P-K-S-Zn-B) and Radish (180-60-80-18-3 kg ha^{-1} N-P-K-S-Zn) were used. 25% of 100-24-20-9 kg ha^{-1} N-P-K-S was used for Red amaranth production. Sugarcane was harvested on 5-18 Oct. 2020. Radish, Onion and Red amaranth were harvested on 1-5 Jan. 2020, 5-10 Jan. 2020 and 4-5 Dec. 2019, respectively. The yield of Sugarcane, Radish, Onion bulb and Red amaranth was 91.86 t ha^{-1} (57500 pieces), 16.15 t ha^{-1}, 2.85 t ha^{-1} and 2.25 t ha^{-1}, respectively. The gross return of Sugarcane, Radish, Onion and Red amaranth was Tk. 862500 ha^{-1}, Tk. 80750 ha^{-1}, Tk. 256500 ha^{-1}, Tk. 36000 ha^{-1}. The total gross return and gross margin was Tk. 1235750 ha^{-1} and Tk. 866012 ha^{-1} (Table 11.26.3.10).

Picture 11.55. Production program of intercropping at FSRD Site: Sholakundu, Faridpur

Farmers showed interest to cultivate chewing type Sugarcane with different vegetables and spices. Intercropping of Onion with Sugarcane was found profitable.

Table 11.26.3.10. Yield, cost and return of different crops at FSRD site Sholakundu, Faridpur during 2019-2020

Year	Variety	Yield (t ha^{-1})	GR (Tk.ha^{-1})	TVC (Tk.ha^{-1})	GM (Tk.ha^{-1})
2019-20	Radish (BARI Mula-1), Onion (BARI Piaj -1), Red amaranth (BARI Lalshak-1), Sugarcane (Gendari local)	Sugarcane: 91.86 (57500 piece), Radish: 16.15 Onion bulb: 2.85 Red amaranth: 2.25	1235750 (Sugarcane: 862500, Radish: 80750, Onion: 256500, red amaranth: 36000)	369738	866012

Market price of output (Tk.kg^{-1}): Sugarcane: 15.00 per piece, Radish: 5.00, Onion: 90.00 and red amaranth: 16.00

FSRD Site: Atia, Tangail

BARI released different crop varieties were used for conduction of production program during the years of 2018 to 2020 (Table 11.26.4).

Table 11.26.4. Different operations conducted for production program at FSRD site, Atia, Tangail during 2018 to 2020.

Crop	Variety	No. of farmers	Total area (ha)	Date of sowing/ transplanting	Date of harvesting
Mustard	BARI Sarisha -14	29	5.53	14-24 Nov.	03-11 February
	BARI Sarisha-17	25	3.90	16-24 Nov.	5-12 February
Barley	BARI Barley -6	8	1.15	20-26 Nov.	15 Feb-09 March
	BARI Barley -7	7	1.11		
Potato	BARI Alu-41	21	2.92	25 Nov.-04 Dec	20- 27 Feb.

Picture 11.56. Production program of Mustard at FSRD Site: Atia, Tangail

Mustard: The Production program was conducted in the farmer's field of the FSRD site, Atia, Delduar, Tangail during rabi season of 2018-1920, 2019-20 and 2020-2021 for increasing area and production of Mustard. The variety viz. BARI Sarisha-14 and BARI Sarisha-17 were used in this production program. The number of cooperators farmers of BARI Sarisha-14 were 29 covered by 5.53 ha of land and BARI Sarisha-17 were 25 covered by 3.90 ha of land. The seeds of BARI Sarisha-14 were sown on 14-24 November and BARI Sarisha-17 was 16-24 November at the rate of 6 kg seed ha^{-1}. The crop was harvested during 3-11 February and 5-12 February, respectively (Table 11.26.4). The average yield of BARI Sarisha-14 was 1.57 t ha^{-1} and BARI Sarisha-17 was 1.65 t ha^{-1} with gross margin Tk. 34114 and Tk. 37531 ha^{-1}, respectively (Table 11.26.4.1). Rovral 50WP was sprayed twice to control Alternaria leaf blight and white mould diseases. Farmers reacted positively and were satisfied with higher seed yield and economic return than local variety. Several amounts of seed has been stored by the farmers for growing mustard in the next year.

Table 11.26.4.1. Yield, cost and return of mustard varieties at FSRD site Atia, Tangail during February to December 2020

Year	Variety	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Cost of Production (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
Feb. 2018 to Jan 2019	BARI Sarisha-14	1.55	2.32	72070	39402	32664
	BARI Sarisha-17	1.66	2.45	77150	39402	37748
Feb. 2019 to Jan 2020	BARI Sarisha-14	1.59	2.42	73970	38407	35563
	BARI Sarisha-17	1.63	2.37	75720	38407	37313
Feb. 2020 to . Jan 2021	BARI Sarisha-14	1.56	2.37	73020	38904	34114
	BARI Sarisha-17	1.65	2.41	76435	38904	37531
Average	BARI Sarisha-14	1.57	2.37	73020	38904	34114
	BARI Sarisha-17	1.65	2.41	76435	38904	37531

Unit Price: Mustard seed =45 and stover=1.00

Barley: The Production program was conducted in the farmer's field of the FSRD site, Atia, Delduar, Tangail during rabi season of 2018-19 and 2019-20 for increasing area and production of Barley. The variety viz. BARI Barley-6 and BARI Barley-7 were used in this production program. The number of cooperators farmers were 15 covered by 2.26 ha of land. The seeds were sown on 20-26 November at the seed rate of 120 kg ha^{-1}. The crop was harvested during 7-14 March (Table 11.26.4). The average yield of

BARI Barley-6 was 1.97 t ha^{-1} and BARI Barley-7 was 2.05 t ha^{-1} with gross margin in Tk. 23408 and Tk. 25448 ha^{-1}, respectively (Table 11.26.4.2). No remarkable pest and disease infestation was observed in the field during the crop period. Farmers showed their interest in new and promising BARI barley varieties due to awn less, higher yield, less disease infection and benefit than local variety. A good amount of seed has been stored by the farmers for growing Barley in the next year.

Table 11.26.4.2. Yield, cost and return of Barley varieties at FSRD site Atia, Tangail during 2018 to 2020

Year	Variety	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Gross return (Tk.ha^{-1})	TVC (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
Feb. 2018 to Jan 2019	BARI Barley-6	1.95	191	50660	30875	19785
	BARI Barley-7	1.98	1.88	51380	30875	20505
Feb. 2019 to Jan 2020	BARI Barley-6	1.99	1.85	51600	24570	27030
	BARI Barley-7	2.12	1.96	54960	24570	30390
Average	BARI Barley-6	1.97	1.88	51130	27723	23408
	BARI Barley-7	2.05	1.92	53170	27723	25448

Barley grain price = Tk.20.00 kg^{-1}and Straw price= Tk.1.00 kg^{-1}

Potato: BARI Alu-41 was cultivated among five farmers covered by 1.40 ha of land to popularize Potato variety among the farmers and increase yield and economic return of the farmers. Seeds were sown on 21-25 November at the @ 1600 kg ha^{-1} of seeds and harvested during 17-19 February (Table 11.26.4). For controlling vector admire was sprayed twice and to prevent late of Potato, wilt and other fungal diseases Indofil-M 45 was sprayed 3 times in the field. BARI Alu-41 produced tuber yield 31.52 t ha^{-1} with gross margin in Tk. 173587 (Avg. of two years) Table 11.26.4.3. Farmers showed their interest in new and promising Potato variety due to higher yield, less disease infection and higher benefit than local variety.

Picture 11.57. Production program of Potato at FSRD Site: Atia, Tangail

Table 11.26.4.3. Tuber yield, cost and return of BARI Alu-41at FSRD site, Atia, Tangail during 2019 to 2021

Year	Variety	Tuber Yield (t ha^{-1})	Gross return (Tk.ha^{-1})	TVC (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
Feb. 2019 to Jan 2020	BARI Alu-41	31.57	315700	141663	174037
Feb. 2020 to Jan. 2021	BARI Alu-41	31.48	314800	141663	173137
Average		31.52	315250	141663	173587

Tuber price= Tk.10.00 kg^{-1}

FSRD Site: Tarakandi, Sherpur

BARI released different crop varieties were used for production program during the years of 2018 to 2020 at FSRD site Tarakandi, Sherpur (Table 11.26.5).

Table 11.26.5. Different operations conducted for production program at FSRD Site, Tarakandi, Sherpur during 2018-2020

Crop	Variety	No. of farmers	Total area (ha)	Date of sowing/ transplanting	Date of harvesting
Mustard	BARI Sarisha-14	1	0.5	03-06 Nov.	21-22 Jan.
Okra	Hybrid variety shakti	1	0.1	15-18 March	1-25 May
Potato	BARI Alu-35	1	0.5	28-30 Nov.	19-20 Feb.

Mustard: The Production program on Mustard (var. BARI Sarisha-14) was conducted in one farmer's field with land size 0.5 ha at FSRD site, Tarakandi, Sherpur during rabi season of the year 2018-19. The seeds of BARI Sarisha-14 were sown on 3-6 November. Rovral 50WP were sprayed twice to control Alternaria leaf blight and white mould diseases. The crop was harvested during 21-22 January (Table 11.26.5). The average seeds yield of BARI Sarisha-14 were found 1.37 t ha^{-1} with gross margin in Tk. 31510 (Table 11.26.5.1). Farmers opined positively and were satisfied with higher seed yield and economic return than local variety. A good amount of seeds were stored by the farmers for growing in the next year.

Table 11.26.5.1. Seed yield, cost and return of mustard variety at FSRD site, Tarakandi, Sherpur during 2018-2019

Year	Variety	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Gross return (Tk.ha^{-1})			Cost of production (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
				Grain	Straw	Total		
2018-19	BARI Sarisha-14	1.37	1.81	57540	3620	61160	29650	31510

Market price of output (Tk.Kg^{-1}): Seed=42 and Stover=2.00.

Okra: The Production program was conducted in the farmer's field of the FSRD site, Tarakandi, Sherpur during rabi season of 2019-20 for increasing area and production of Okra. The commercial hybrid variety (var. Shakti) was cultivated under production program. One farmer was selected with a land size 0.1 ha. The seeds were sown on 15-18 March. Systemic insecticides were sprayed twice at pre fruit setting stage to control white fly and other sucking insects. Harvesting of Okra started from 1st May and it was continued up to 25th May (Table 11.26.5). The average fruit yield was 28.82 t ha^{-1} with gross margin in Tk. 144590 (Table 11.26.5.2). Farmers were satisfied with higher fruit yield and economic return than local variety.

Table 11.26.5.2. Fruit yield, cost and return of Okra variety at FSRD site, Tarakandi, Sherpur during 2019-2020

Year	Variety	Fruit yield (t ha^{-1})	Gross return (Tk.ha^{-1})			Cost of production (Tk.ha^{-1})	Gross margin (Tk..ha^{-1})
			Fruit	Straw	Total		
2019-20	Hybrid Shakti	28.82	345840	-	345840	201250	144590

Market price of output (Tk.Kg^{-1}): Okra=12.

Potato: The Production program was conducted in one farmers field with a land size 0.5 at the FSRD site, Tarakandi, Sherpur during rabi season of the year 2019-2020. The variety viz. BARI Alu-35, BARI Alu-36, BARI Alu-37, BARI Alu-40 and BARI Alu-41 were used in this production program.The tubers of Potato were sown on 28-30 November. Dithane-M 45 and Ridomil gold was sprayed to control late blight disease. The crop was harvested during 19-20 February (Table 11.26.5). The average tuber yield of Potato was found 40.62 t ha^{-1} with gross margin in Tk. 312298 (Table 11.26.5.3). Farmers were satisfied with higher tube yield and economic return.

Picture 11.58. Production program of Potato at FSRD site, Tarakandi, Sherpur

Table 11.26.5.3. Tuber yield, cost and return of potato variety at FSRD site, Tarakandi, Sherpur during 2019-2020

Year	Variety	Tuber yield (t ha^{-1})	Gross return (Tk.ha^{-1})	Cost of production (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
2019-20	BARI Alu-35	40.06	480720	175190	35530
	BARI Alu-36	41.35	496200	175190	321010

Year	Variety	Tuber yield (t ha^{-1})	Gross return (Tk.ha^{-1})	Cost of production (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
	BARI Alu-37	44.26	531120	175190	355930
	BARI Alu-40	40.22	482640	175190	307450
	BARI Alu-41	37.23	446760	175190	271570
Average	-	40.62	487488	175190	312298

Market price of output (Tk.Kg^{-1}): Potato=12.

11.27. Production program with modern rice varities at FSRD site Tengra, Sreepur, Gazipur (BRRI) during 2018 to 2020

Aus rice variety:

Under Production program yield and cost-return of Aus rice varieties during 2018- 2020 were presented in the Table 11.27.1 In the Aus season BRRI dhan27, BRRI dhan43, BRRI dhan48, BRRI dhan65 BRRI dhan82, BRRI dhan83 and BRRI dhan 85 were tested during 2018-2020. Among the seven Aus rice varieties BRRI dhan83 produced the average highest yield (5.01 t/ha) followed by BRRI dhan48 (4.91 t/ha), BRRI dhan82 (4.55 t/ha), BRRI dhan85 (4.15 t/ha). BRRI dhan65 (3.63 t/ha) and BRRI dhan43 (2,78t/ha). The lowest yield was observed in BRRI dhan27 (2.19 t/ha). Considering the cost-return analysis, it was found that BRRI dhan83 performed better compared to all other tested Aus rice varieties. The highest average gross margin Tk. 37180 /ha, was found from BRRI dhan83 during Aus season 2018 - 2020. Farmers opinioned that cultivation of Aus rice is possible but good price of rice need to be ensured.

Table 11.27.1. Yield and cost-return of Aus Rice variety at FSRD site, Tengra, Sreepur, Gazipur 2018-2020

	Yield (t ha^{-1})		Gross return (Tk.ha^{-1})			Total variable Cost (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
Variety	Grain	Straw	Grain	Straw	Gross return		
BRRI dhan27	2.19	4.85	39420	9700	49120	61800	-12680
BRRI dhan43	2.78	4.3	50040	8600	58640	61800	-3160
BRRI dhan48	4.91	4.57	88440	9133	97573	61467	36107
BRRI dhan65	3.63	4.2	65400	8400	73800	61467	12333
BRRI dhan82	4.55	4.35	81900	8700	90600	62100	28500
BRRI dhan83	5.01	4.4	90180	8800	98980	61800	37180
BRRI dhan85	4.15	4.45	74700	8900	83600	60200	23400

Market price of output (Tk.Kg^{-1}): Rice= 18.00 and Straw= 2.00

Aman rice variety:

Under Production program yield and cost-return of T. Aman rice varieties during 2018- 2020 were presented in the Table 11.27.2. During the Aman season from 2018-2020 seven high yielding varieties of Aman rice were under production program. The varieties were BRRI dhan51, BRRI dhan57, BRRI dhan71, BRRI dhan72, BRRI dhan75, BRRI dhan80, and BRRI dhan87 (11.27.2). Among the tested varieties BRRI dhan71 produced the average highest yield (4.92t/ha) followed by BRRI dhan75 4.46 t/ha). The lowest yield was observed in BRRI dhan72 (3.44 t/ha). Considering the cost return analysis, it was found that BRRI dhan71, BRRI dhan75 and BRRI dhan87 performed better compared to all other tested Aman rice varieties during 2018, 2019 and 2020, respectively. The average higher gross margin Tk. 25000 /ha, Tk. 24073 /ha and Tk. 19020/ha was found from BRRI dhan71, BRRI dhan75 and BRRI dhan80, respectively. Farmers opinioned that, cultivation of modern Aman rice varieties increased their production and income.

Table 11.27.2. Yield and cost-return of Aman Rice variety at FSRD site, Tengra, Sreepur, Gazipur during 2018-2020

	Yield (t ha^{-1})		Gross return (Tk.ha^{-1})			Total variable cost (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
Variety	Grain	Straw	Grain	Straw	Gross return		
BRRI dhan51	3.74	4.16	67260	8327	75587	72500	3087
BRRI dhan57	3.76	4.05	67680	8100	75780	72500	3280
BRRI dhan71	4.92	4.44	88620	8880	97500	72500	25000
BRRI dhan72	3.44	4.4	61920	8800	70720	72500	-1780
BRRI dhan75	4.86	4.58	87420	9153	96573	72500	24073
BRRI dhan80	4.58	4.54	82440	9080	91520	72500	19020
BRRI dhan87	4.57	4.45	82170	8900	91070	72500	18570

Market price of output (Tk.Kg^{-1}): Rice= 18.00 and Straw= 2.00

Boro rice variety:

Under Production program yield and cost-return of Boro rice varieties during 2018- 2020 were presented in the Table 11.27.3. During the Boro season from 2018-2020 nine high yielding varieties of Boro rice were under production program. The varieties were BRRI dhan28, BRRI dhan50, BRRI dhan63, BRRI dhan67 BRRI dhan69, BRRI dhan74, BRRI dhan81, BRRI dhan84 and BRRI dhan88. Among the tested varieties BRRI dhan67 produced the average highest yield (5.75 t/ha) followed by BRRI dhan69 (5.66 t/ha) and BRRI dhan50 (5.49 t/ha). The lowest yield (4.60 t/ha) was observed in BRRI dhan74 (Table 11.27.3). Considering the cost return analysis, it was found that BRRI dhan50 performed better compared to all other tested varieties during Boro season. The highest average gross margin Tk. 61825 /ha was found from BRRI dhan50 and the lowest gross margin Tk. 7220/ha was found from BRRI dhan81 during Boro season from 2018-2020. Farmers opinioned that, BRRI dhan50 is a good variety in Boro season considering yield and economic return. It has high demand in the market due to its grain quality and aroma. BRRI dhan50 always produced higher return than other varieties due to its high market price.

Table 11.27.3. Yield and cost-return of Boro Rice variety at FSRD site, Tengra, Sreepur, Gazipur, during 2018-2020

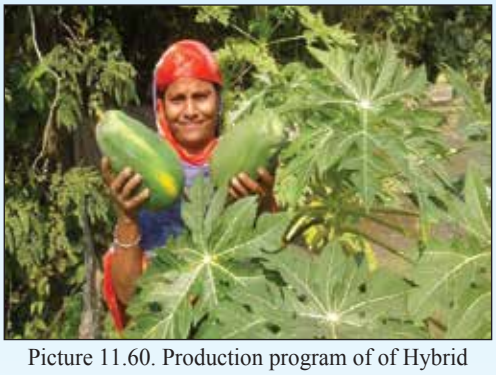
	Yield (t ha^{-1})		Gross return (Tk.ha^{-1})			Total variable cost (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
Variety	Grain	Straw	Grain	Straw	Gross Return		
BRRI dhan28	4.7	5.005	84600	10010	94610	86000	8610
BRRI dhan50	5.49	5.35	137125	10700	147825	86000	61825
BRRI dhan63	5.23	5.5	94140	11000	105140	88500	16640
BRRI dhan67	5.75	5.22	103500	10440	113940	83500	30440
BRRI dhan69	5.66	5.16	101880	10320	112200	83500	28700
BRRI dhan74	4.60	4.55	82800	9100	91900	83500	8400
BRRI dhan81	4.54	4.5	81720	9000	90720	83500	7220
BRRI dhan84	4.82	5.15	86670	10300	96970	86000	10970
BRRI dhan88	5.24	5.88	94320	11760	106080	88500	17580

Market price of output (Tk.Kg^{-1}): Rice= 18.00, BRRI dhan50=25.00 and Straw= 2.00

Picture 11.59 Production program of modern Aus, Aman and Boro rice varieties at FSRD site, Tengra, Sreepur, Gazipur

11.28. Production of Hybrid Papaya (var. Red lady) in farmer's field at FSRD Site Mokamia, Fulpur, Mymensingh (BFRI)

The production program of Hybrid Papaya (var. Red lady) conducted at four farmers field at FSRD site Mokamia Fulpur Mymensingh during April 2018. Average plot size of each farmer was 4 decimal. Harvesting of fruits was started in June, 2018. The average production of green papaya after six months was 750 kg/4 decimal of land (46.87 t /ha). About 625 kg of green papaya/farmer was found to sell and the rest 125 kg was consumed. It was also found that the average gross retrun /farmer after 6 months was about Tk. 12,500 and average gross margin/farmer was Tk. 10100 (Table 11.28.1). The monthly family income of the farmer was increased due to intervention of this technology. The income was used for crop production, house repairing, children's education and sanitation etc.



Picture 11.60. Production program of of Hybrid Papaya at Mokamia, Fulpur, Mymensingh

Table 11.28.1. Yield and economics of Papaya production program at FSRD site, Mokamia, Fulpur, Mymensingh during April - November, 2018

Crop	Date of planting	Date of harvesting	Yield (Kg/4 dec.)	Yield (t/ha)	Utilization pattern		Gross return (Tk./ 4 dec.)	Variable cost (Tk/.4 dec.)	Gross margin (Tk./ 4 dec.)
					Sell (Kg)	Consumption (Kg)			
Papaya	April, 2018	June, 2018	750	46.87	625	125	12,500	2400	10100

**The average sell price of green papaya was Tk.20/kg*

11.29. Production program of Summer Tomato at farmer's field at FSRD Site Mokamia, Fulpur, Mymensingh (BFRI)

The production program of summer tomato (BARI Hybrid Tomato- 4) was conducted at four farmers field at FSRD site Mokamia Fulpur Mymensingh in April 2018. Average plot size of each farmer was 4 decimal. Tomato seedling transplanted on July 2018. Harvesting of fruits was started in September, 2018. The average production of tomato was about 360 kg/4 decimal of land i.e. 22.50 t/ha (Table 11.29.1). The average cost of production was Tk. 4900 per 4 decimal of summer tomato production. The average gross returan/farmer was Tk. 18,600 from 4 decimal land (Tk. 1148550/ha). The average gross margin /farmer was Tk. 13,700 from 4 decimal land (Tk. 845975 /ha). It was found that due to off season production the market value of tomato was high. However, within a short period of time the farmers made a good profit through the cultivation of off-season summer tomato.

Table 11.29.1. Yield and economics of summer tomato production program at FSRD site, Mokamia, Fulpur, Mymensingh during July– September, 2018

Crop	Date of panting	Date of harvesting	Yield/4 decimal	Yield (T/ha)	Utilization pattern		Gross return (Tk./ 4 dec.)	Variable cost (Tk./ 4 dec.)	Gross margin (Tk./ 4 dec.)
					Sell (Kg)	Consumption (Kg)			
Summer tomato	July 2018	September 2018	360 kg	22.50	300	60	18,600	4900	13,700

**The average sell price of tomato was Tk.40/kg. It may vary from place to place.*

Picture 11.61. Production program of of Hybrid summer tomato at Mokamia, Fulpur, Mymensingh

11.30. Production program of HYV Aus rice at farmers field at FSRD Site Mokamia, Fulpur, Mymensingh (BFRI)

The production program on Aus rice (Binadhan -19) was conducted in five farmers field at FSRD site Mokamia, Fulpur Mymensingh during 2019. A total land area of 5 farmers were 1.10 ha. The crop harvested 90 days after transplantation of seedlings. Average yield of T. Aus rice was found 4.40 t/ha. While gross return Tk. 54401, cost of production Tk. 18932 and gross margin was Tk. 35469/ha, respectively (Table 11.30.1). Generally, T. Aus rice was not cultivated in the farming system area. After Boro rice, the field became fallow. First time, through farming system intervention, Binadhan - 19 was introduced in the area. Farmers were very happy for getting straw as by product for their cattle. However, farmers will continue T. Aus rice cultivation in this area.

Table 11.30.1. Yield and economics of production program of T. Aus at FSRD Site Mokamia, Fulpur, Mymensingh during May-August 2019

Rice Variety	Total area (ha)	Duration (days)	Yield (t/ha)	Gross return (Tk./h)	Variable cost (Tk./h)	Gross margin (Tk./ha^{-1})
Binadhan-19	1.01	90	4.40	54401	18932	35469

Picture 11.62. Production program of T.Aus at Mokamia, Fulpur, Mymensingh

11.31. Production program of Pani Kachu (var. BARI Panikachu-1) in fallow lands near by homestead at FSRD Site Mokamia, Fulpur, Mymensingh (BFRI)

The production program on Panikachu (var. Latiraj) was conducted at five farmers field near by homestead at FSRD site Mokamia, Fulpur, Mymensingh during during 2019. Total land area of 5 farmers was 0.44 ha. The average production of stolen was 2.20 t/ha of 20 decimal of land (27.0 t/ha) and the average production of curd was 1.85 t/ of 20 decimal of land (22.0 t/ha) (Table 11.31.1). The average income/farmer form stolen was Tk. 22,000/20 decimal of land (Tk. 2.72000 /ha) and from curd Tk. 18000/20 decimal of land (Tk. 225000 /ha). The average gross return/farmer was Tk. 28,500. The gross return. variable cost and gross margin were Tk. 497000/ha, Tk. 129114/ha and Tk. 367886/ha, respectively.

Table 11.31.1. Yield and cost-return of Latiraj (BARI Panikachu-1) in fallow land near by homested at FSRD site Mokamia, Fulpur, Mymensingh during February-June, 2020

Pani Kachu (var. Latiraj)	Yield (t/ha)		Gross retrun (Tk./ha)	Total variable cost (Tk./ha)	Gross margin (Tk./ha)
	Stolen	Card			
	27.00	22.00	497000	129114	367886

** The average sell price of stolon @ Tk.10/kg and the curd was Tk..10/piece.*

Picture 11.63. Production program of Panikachu at Mokamia, Fulpur, Mymensingh

11.32. Production Program of Ladies finger (BARI Dherosh-2) in the farmers field at FSRD Site Mokamia, Fulpur, Mymensingh (BFRI)

From 15 decimal lands, the average production of ladies finger was 600 kg (Table 11.32.1). While the average gross return, variable cost and gross margin per farmer was Tk. 60000, Tk. 25000 and Tk. 35000 from 15 decimal of land respectively. It was found that due to COVID 19, the price of ladies finger was very low. However, within a short period the farmers made a profit through the cultivation of ladies finger. The profit was being used for another vegetable production, house repairing, children's education and sanitation etc.

Table 11.32.1. Production program of Ladies finger at FSRD site Mokamia, Fulpur, Mymensingh during April- Mid August, 2020

Crop	No. of farmer involved	Date of sowing	Date of harvesting of fruits	Average yield (Kg/15 dec.)	Gross return (Tk. /15 dec.)	Variable cost (Tk. /15dec.)	Gross margin (Tk. /15dec.)
Ladies finger (var. BARI Dherosh-2)	06	April-May 2020	June -Aug 2020	600	60000	25000	35000

** The average sell price of ladies finger @ Tk.10/kg.*

Picture 11.64. Production program of Ladies finger at FSRD site Mokamia, Fulpur, Mymensingh

11.33. Production Programe of HYV Cucumber (var. Field King) by Organic Manure at FSRD Site Mokamia, Fulpur, Mymensingh (BFRI)

The average production of cucumber was about 2.7 t/15 decimal of land (Table 11.33.1). Produced cucumber was used for both consumption and selling. On an average of 2.4 tons of cucumber was found to sell and the rest 300 kg was found to consume. The average gross margin was Tk. 26500/ 15 decimal of land.

Picture 11.65. Production program of Cucumber at FSRD site Mokamia, Fulpur, Mymensingh

Table 11.33.1. Production program of Cucumber at FSRD site Mokamia, Fulpur, Mymensingh during March – July 2020

Name of Vegetable & Variety	No. of Farmer	Area of land (dec.)	Average yield (t)/15 dec.	Average Consumption (Kg)	Average sold/15 dec.	Gross return (Tk./15 dec.)	Variable cost (Tk./15 dec.)	Gross margin (Tk. /15 dec.)
Cucumber (Field King)	03	15	2.90	350	2.50 tons	50,000	23,500	26,500

** The average sell price of produced cucumber was Tk.20/kg but it may vary from time to time and place to place.*

C. Livestock System

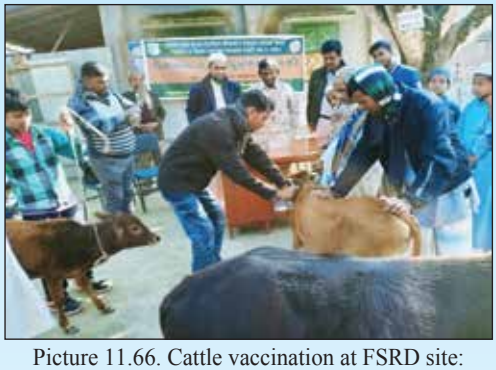
BARI Component

11.34. Vaccination and deworming of cattle at different FSRD sites during 2018- 2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Number of livestock under vaccination program, name of the vaccines applied to the selected cattle, dates of vaccination are presented in Table Table 11.34.1. A total of 244 numbers of livestock including buffalo, cow, ox, calf and goat were vaccinated. Frequency of diseases was listed among the cooperative farmers. It

was found that, before vaccination frequency of different diseases was higher (15-34%). After vaccination of livestock, all of the disease's frequency reduced around 2-7% (Table 11.34.1). This technology was easy to adopt with minimum cost involvement. That's why the cooperator farmers were interested and adopted this technology as per routine work.



Picture 11.66. Cattle vaccination at FSRD site: Ajoddhapur, Rangpur

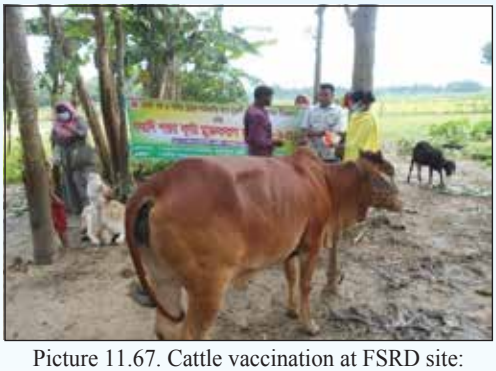
Table 11.34.1. Mortality (%) of livestock before and after vaccination against major diseases at FSRD site, Ajoddhapur, Rangpur during 2018 to 2021

Year of vaccination	Name of the vaccine	No. of livestock Vaccinated		Percentage of disease frequency (%)	
		Cattle	Goat	Before vaccination	After vaccination
Year I	Anthrax, PR,FMD	48	2	15-34	4-7
Year II	Anthrax, PR, BQ, FMD	110	12	15-34	3-4
Year III	Anthrax, PR, BQ, FMD	62	10	15-34	2-4
Total		220	24	Range 15-34	Range 2-7

* Year I=Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD site: Ganggarampur, Pabna (BARI)

Vaccination technology was found easy to adopt with minimum cost involvement. That's why the cooperator farmers were interested and adopted this technology as per routine work. Table 11.34.2 shows the information on number of cattle under vaccination program, name of the vaccines applied to the selected cattle and dates of vaccination. Total number of livestock brought under vaccination program was 408 at FSRD site, Ganggarampur, Pabna during the years of 2018 to 2021. Percentage of mortality before and after vaccination was recorded among the cooperator farmers. It was found that before vaccination mortality rate of cattle was higher (5-10%). After vaccination of cattle, all of the diseases frequency reduced drastically and mortality rate was almost nil or around 2-3%.



Picture 11.67. Cattle vaccination at FSRD site: Ganggarampur, Pabna

Table 11.34.2. Mortality (%) of livestock before and after vaccination against major diseases at FSRD site Ganggarampur, Pabna during 2018 to 2021

Year of vaccination	Name of Vaccine	No. of Cattle vaccinated	Percentage of mortality (%)	
			Before intervention	After intervention
Year I	BQ	95	10	0
	FMD	40	5	0
Year II	Anthrax	77	5	3
	Paraclear	25	6	3
	FMD	77	10	2
Year III	Anthrax	49	6	0
	FMD	45	9	0
Total		408	Range 5-10	Range 0-3

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sholakundu, Faridpur (BARI)

Total 300 numbers of livestock were brought under deworming and vaccination program in FSRD site, Sholakundu, Faridpur (Table 11.34.3). Livestock diseases (Anthrax and FMD) in the selected areas occurred before and after vaccination were recorded cautiously. It was observed that, before de-worming and vaccination frequency of different diseases was higher and mortality rate was 13-15% while after deworming and vaccination of cattle all of the diseases frequency reduced and most of the treated animals were free from Anthrax and FMD. Mortality rate also decreased (0%). Frequency of diseases was listed among the cooperative farmers. Local and cross breed livestock both were brought under vaccination program.

Picture 11.68. Cattle vaccination at FSRD site: Sholakundu, Faridpur

Table 11.34.3. Mortality (%) of livestock before and after vaccination against major diseases at FSRD site Sholakundu, Faridpur during 2018 to 2021

Year of vaccination	Name of disease	No. of Cattle Vaccinated	Percentage of mortality (%)	
			Before vaccination	After vaccination
Year I	Anthrax	100	15	0
Year II	Anthrax	100	13	0
Year III	FMD	100	14	0
Total		300	Range 13-15	0

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

Number of livestock under deworming and vaccination program, name of the vaccine applied to the selected cattle and percentage of mortality are presented in Table 11.34.4. Total number of livestock brought under deworming and vaccination program were 477 in FSRD site, Atia, Tangail. It was observed that, before de-worming and vaccination frequency of different diseases was higher and mortality rate was 9-12% while after deworming and vaccination of cattle all of the diseases frequency reduced and most of the treated animals were free from Anthrax and FMD. Mortality rate also decreased (1-4%). Frequency of diseases was listed among the cooperative farmers. Local and cross breed livestock both were brought under vaccination program.

Picture 11.69. Deworming and vaccination program at FSRD site: Atia, Tangail

Table 11.34.4. Mortality (%) of livestock before and after vaccination against major diseases at FSRD site, Atia, Tangail during 2018 to 2021

Year of vaccination	Name of disese	No. of Cattle Vaccinated	Percentage of mortality (%)	
			Before vaccination	After vaccination
Year I	Anthrax and FMD	80	9-12	1-2
Year II	Anthrax and FMD	183	9-12	3-4

Year of vaccination	Name of disese	No. of Cattle Vaccinated	Percentage of mortality (%)	
			Before vaccination	After vaccination
Year II	Anthrax and FMD	214	9-12	2-3
Total		477	Range 9-12	Range 1-4

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur (BARI)

Total number of livestock brought under deworming and vaccination program were 228 at FSRD site, Tarakandi, Sherpur during the years of 2019 to 2021 (Table 11.34.5). It was observed that, before de-worming and vaccination frequency of different diseases was higher and mortality rate was 5-10% while after deworming and vaccination of livestock all of the diseases frequency reduced and most of the treated animals were free from Anthrax, FMD and PPR. Frequency of diseases werw listed among the cooperative farmers. Local and cross breed livestock both were brought under vaccination program.

Table 11.34.5. Mortality (%) of livestock before and after vaccination against major diseases at FSRD site, Tarakandi, Sherpur during 2019 to 2021

Year of vaccination	Name of the vaccine	No. of livestock Vaccinated			Percentage of mortality (%)	
		Cattle	Goat	Sheep	Before vaccination	After vaccination
Year I1	Anthrax, FMD and PPR	100	50	5	10	0
Year II1	Anthrax, FMD and PPR	65	5	3	5	0
Total		165	55	8	Range 5-10	0

* Year 11 = Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.35. Vaccination of poultry bird at different FSRD sites during 2018 -2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Poultry vaccination program was performed during 2018-2021. Four different types of vaccines (BCRDV, RDV, Duck plague and Pigeon Pox) were applied on 1183 poultry birds (Table 11.35.1). Mortality rate was reduced and went below 2-7% after vaccination program.

Picture 11.70. Poultry vaccination program at FSRD site: Ajoddhapur, Rangpur

Table 11.35.1. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

Year of vaccination	Name of the vaccine	No. of poultry birdsVaccinated				Percentage of mortality (%)	
		Chicken	Duck	Pigeon	Turkey	Before vaccination	After vaccination
Year I	BCRDV, RDV, DuckPlague andPigeon Pox	398	46	10	-	14-22	3-4

Year of vaccination	Name of the vaccine	No. of poultry birdsVaccinated				Percentage of mortality (%)	
		Chicken	Duck	Pigeon	Turkey	Before vaccination	After vaccination
Year II	BCRDV, RDV, Duck Plague and Pigeon Pox	274	47	24	60	14-22	2-6
Year II	BCRDV, RDV, Duck Plague and Pigeon Pox	136	18	50	120	14-22	2-7
Total		808	111	84	180	Range 14-22	Range 2-7

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna (BARI)

Vaccination program on poultry birds was conducted during 2018- 2020 (Table11.35.2). The numbers of different types of vaccinated poultry were 450, 300, 100 and 150 in case of BCRDV, RDV, Fowl Pox and Fowl Colera, respectively, during 2018-19 while the number of chickens was 310 and 500 in case of BCRDV and RDV, respectively during 2019-20. It was found that before vaccination mortality (%) of poultry birds due to different diseases was higher (15-30%). After vaccination of poultry, all of the diseases reduced drastically and mortality rate was recorded about 2-6% (Table 11.35.2).

Table 11.35.2. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD site, Ganggarampur, Pabna during 2018 to 2020

Year of vaccination	Name	No. of Chicken vaccinated	Percentage of mortality	
			Before vaccination	After vaccination
Year I	BCRDV	450	30	5
	RDV	300	20	4
	Fowl pox	100	20	5
	Fowl cholera	150	15	6
Year II	BCRDV	310	20	3
	RDV	500	15	2
Total		1810	Range 15-30	Range 2-6

* Year I= Feb.2018-Jan.2019 and Year II= Feb.2019-Jan.2020

FSRD Site: Sholakundu, Faridpur (BARI)

Vaccination program on chicken and duck was conducted during 2018 to 2021. Name of the vaccines and number of the poultry are given in Table 11.35.3. Name of the vaccines used in the program was BCRDV, RDV and duck plague. Total 1390 poultry birds and 50 ducks were vaccinated against different diseases. It was observed that before vaccination mortality rate was higher (23-30 %) because of different diseases infestation. After vaccination all of the disease's frequency and mortality rate reduced (0-11 %).

Picture 11.71. Poultry vaccination program at FSRD site: Sholakundu, Faridpur

Table 11.35.3. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD site Sholakundu, Faridpur during 2018 to 2021

Year of vaccination	Name of the vaccine	No. of poultry birds Vaccinated		Percentage of mortality (%)	
		Chicken	Duck	Before intervention	After intervention
Year I	BCRDV	150	--	30	10
	Duck plague	--	50	25	0

Year of vaccination	Name of the vaccine	No. of poultry birds Vaccinated		Percentage of mortality (%)	
		Chicken	Duck	Before vaccination	After vaccination
Year II	BCRDV	315	--	30	8
	RDV	425	--	25	11
Year III	BCRDV	200	--	25	4
	RDV	300	--	23	6
Total		1390	50	Range 23-30	Range 4-11

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

Vaccination program on chicken and duck was conducted at FSRD site Atia, Tangail during 2018 to 2021. Name of the vaccines used in the program was BCRDV, RDV, Fowl Pox, Fowl cholera and duck plague. Total 816 chicken and 439 ducks were vaccinated against different diseases (Table 11.35.4). It was observed that before vaccination mortality rate was higher (20-24%) because of different diseases infestation. After vaccination all of the disease's frequency reduced (2-5%).

Picture 11.72. Poultry vaccination program at FSRD site: Atia, Tangail

Table 11.35.4. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD site, Atia, Tangail during 2018 to 2021

Year of vaccination	Name of the vaccine	No. of poultry birds Vaccinated		Percentage of mortality (%)	
		Chicken	Duck	Before vaccination	After vaccination
Year I	BCRDV, RDV, Fowl pox, Fowl cholera and Duck plague	211	85	20-24	2-5
Year II	BCRDV, RDV, Fowl pox, Fowl cholera and Duck plague	319	168	20-24	2-4
Year III	BCRDV, RDV, Fowl pox, Fowl cholera and Duck plague	286	186	20-24	3-5
Total	BCRDV, RDV, Fowl pox, Fowl cholera and Duck plague	816	439	Range 20-24	Range 2-5

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur (BARI)

Vaccination program on chicken, duck and Pigeon was conducted during 2018 to 2021 (Table 11.35.5). Name of the vaccines used in the program was BCRDV, RDV, Gamboro and Duck plague. Total 634 poultry birds were vaccinated against different diseases (Table 11.35.5). It was observed that before vaccination mortality rate was higher (25-30%) because of different diseases infestation. After vaccination all of the disease's frequency was reduced and mortality rate (5-8%).

Table 11.35.5. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD site Tarakandi, Sherpur during 2018 to 2021

Year of vaccination	Name of the vaccine	No. of poultry birds Vaccinated			Percentage of mortality (%)	
		Chicken	Duck	Pigeon	Before vaccination	After vaccination
Year I	BCRDV, RDV, Gamboro and Duck Plague	150	30	10	30	8
Year II	BCRDV, RDV and Duck Plague	200	30	8	25	5
Year II	BCRDV,RDV and Duck Plague	153	53	-	25	8
Total		503	113	18	Range 25-30	Range 5-8

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.36. Vaccination program on cattle, goats and chickens at FSRD site Tengra, Sreepur, Gazipur during 2018 -2021

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

A total number of 998, 342, 1172, 362, 367 and 300 cattle, goat, chicken, duck, pigeon and turkey were vaccinated, respectively (Table 11.36.1 and Table 11.36.2). It was observed that before vaccination mortality rate of livestock and poultry birds were higher (8-15%) and (20-30%), respectively, because of different diseases infestation. After vaccination all of the disease's frequency was reduced and mortality rate of livestock and poultry birds were (0-5%) and (5-10%), respectively. Farmers were interested to continue vaccination of cattle, goat, chicken, duck, pigeon and turkey due to reduction of mortality.

Table 11.36.1. Mortality (%) of livestock before and after vaccination against major diseases at FSRD site Tengra, Sreepur, Gazipur during 2018 to 2020

Year of vaccination	Name of the vaccine	**Number of livestock**		Percentage of mortality (%)	
		Cattle	Goat	Before vaccination	After vaccination
Year I	Khuravax	258		10	02
	PPR		80	15	05
Year II	Lumpy skin	368		08	00
	PPR		262	12	04
	Khuravax	372		08	00
Total		998	342	Range 8-15	Range 0-5

* Year I= Feb.2018-Jan.2019 and Year II= Feb.2019-Jan.2020

Table 11.36.2. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD site Tengra, Sreepur, Gazipur during 2018 to 2021

Year of vacci nation	Name of the vaccine	No. of poultry birds Vaccinated				Percentage of mortality	
		Chicken	Duck	Pigeon	Turkey	Before vaccination	After vaccination
Year I	BCRDV, Fowl Pox, Fowl Cholera				95	20	05

Year of vacci nation	Name of the vaccine	No. of poultry birds Vaccinated				Percentage of mortality	
		Chicken	Duck	Pigeon	Turkey	Before vaccination	After vaccination
Year II	RDV, BCRDV, Fowl Pox, and Fowl Cholera	350	90	55	115	30	15
Year III	RDV, BCRDV, Fowl Pox, and Cholera	822	292	312	90	25	10
Total		1172	362	367	300	Range 20-30	Range 5-10

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Picture 11.73 .Vaccination program at FSRD site Tengra, Sreepur, Gazipur

11.37. Vaccination program on Cattle, Chicken, Duck and Pigeon at FSRD Site Mokamia, Fulpur, Mymensingh (BFRI)

The mortality rate of cattle, chicken, duck and pigeon before vaccination was 3.50, 19.53, 8.50 and 20%, respectively (Table 11.37.1). After vaccination programme, the mortality rate of cattle, chicken, duck and pigeon were 0, 2.83, 2.5 and 10.0%, respectively. After vaccination the mortality rate was reduced significantly. Previously FMD and Duck Plague disease were emerging disease for cattle and duck at the FSRD Site. When farming system activities were initiated and vaccination program was under taken, then the incidence of FMD and Duck Plague diseases reduced significantly. On the other hand, before vaccination on cattle the average milk production was 3 liters/cattle/day. After vaccination, milk production was found 4 liters/cattle/day and average milk production was increased 33%. Well management and proper vaccination can reduce the mortality rate, increase the milk production and also can improve the animal's productivity (Table 11.37.2).

Table 11.37.1. Before and after vaccination of cattle, chicken, duck and pigeon diseases occurred at FSRD Site Mokamia, Fulpur, Mymensingh

Animals	Name of diseases	Before vaccination		After vaccination	
		No of mortality	Mortality rate (%)	No of mortality	Mortality rate (%)
Cattle	Anthrax	2	1	0	0
	FMD	5	2.5	0	0
	Black quarter	0	0	0	0
Total			3.50		0
Chicken	BCRDV	20	3.33	0	0
	RDV	50	8.33	12	2
	Fowl Cholera	10	1.66	0	0
	Fowl pox	30	5.0	5	0.833
	Gumboro Diseases	5	0.833	0	0
Total			**19.53**		**2.83**

Animals	Name of diseases	Before vaccination		After vaccination	
		No of mortality	Mortality rate (%)	No of mortality	Mortality rate (%)
Duck	Duck plaque	30	7.50	10	2.5
	Fowl Cholera	05	1.25	0	0
	Food Poisoning	0	0	0	0
Total			**8.50**		**2.50**
Pigeon	RDV	0	0	0	0
	Pigeon Pox	8	16.0	5	10
	Food Poisoning	2	4.0	0	0
Total			**20.0**		**10.0**

Table 11.37.2. Average milk production of cattle before & after vaccination at FSRD Site Mokamia, Fulpur, Mymensingh

Parameter	Average milk production (liters/cattle/day)
Average initial milk production before vaccination	3.0
Average final milk production after vaccination	4.0
Milk production increased (%)	33.00

Picture 11.74. Vaccination program at FSRD site Mokamia, Fulpur, Mymensingh

11.38. Improvement of cattle health by deworming and vitamin ADE injection at FSRD sites of BARI during 2018 - 2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Number of livestock under deworming program, and their performances are presented in Table 11.38.1. Fifty cattle were dewormed, forty cattle were dewormed with added vitamin ADE and twenty eight cattle were control (no deworming). It was found that deworming as well as vitamin ADE supplementation has positive effect on body weight and lactation period increment. Lactation period was increased about 10% due to deworming.

Picture 11.75. Cattle health improvement by deworming and vitamin ADE injection at FSRD site: Ajoddhapur, Rangpur

Table 11.38.1. Average body weight gain, milk production and lactation period after deworming at FSRD site, Ajoddhapur, Rangpur during 2018 to 2021

Treatment	No. of animal	Avg. body wt. gain day^{-1} animal^{-1} (g)	Avg. Lactation yield (litter day^{-1})	Avg. Lactation period (day)
Controlled Cattle	28	30-40	1	178
Dewormed Cattle	50	70-90	1.75	195
Dewormed+ Vitamin ADE injection treated Cattle	40	70-100	1.8	196

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna (BARI)

Deworming and Vitamin ADE injection have positive effects on cattle health. That's why the co-operator farmers were interested and adopted this technology as per routine work. Table 11.38.2 shows the performance of body weight gain, milk production and lactation period after deworming and vitamin ADE injection. It indicates that maximum body weight gain (310-420 g day-1 animal-1), milk production (1.20-1.50 L day-1) and lactation period (180-210 day) was obtained from deworming and vitamin ADE injection treated cattle followed by dewormed cattle. Relatively lower performance of the above traits was noted from controlled cattle.

Picture 11.76. Cattle health improvement by deworming and vitamin ADE injection at FSRD site: Ganggarampur, Pabna

Table 11.38.2. Average body weight gain, milk production and lactation period after deworming at FSRD site, Ganggarampur, Pabna during 2018 to 2021

Treatment	Year I				Year II				Year III			
	No. of animal	Avg.body wt. gain day^{-1} animal^{-1} (g)	Avg .lactation yield (litreday^{-1})	Avg lactation period (day)	No. of animal	Avg body wt. gain day^{-1} animal^{-1} (g)	Avg .lactation yield (litreday^{-1})	Avg .lactation period (day)	No. of animal	Avg body wt. gain day^{-1} animal^{-1} (g)	Avg lactation yield (litre day^{-1})	Avg.lactation period (day)
Controlled cattle	10	166	0.95	165	6	168	1.1	162	5	220	1.20	163
Dewormed cattle	10	292	1.20	180	6	253	1.39	210	5	310	1.50	175
Dewormed+vitamin ADE injected treated cattle	10	375	1.50	210	6	343	1.60	214	5	420	1.75	169

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sholakundu, Faridpur (BARI)

The performance of body weight gain, milk production and laction period after deworming and vitamin feeding are presented in Table 11.38.3. It was indicated that maximum body weight gain (110-160 g day^{-1}animal^{-1}), milk production (2.65 L day^{-1}) and lactation period (210 days) was obtained from deworming and vitamin feeding treated cattle followed by dewormed cattle and minimum from controlled cattle.

Picture 11.77. Cattle health improvement by deworming and vitamin feeding at FSRD site: Sholakundu, Faridpur

Table 11.38.3. Average body weight gain, milk production and lactation period after deworming at FSRD site Sholakundu, Faridpur during 2018 to 2021

Treatment	No. of animal	Avg. Body wt. gainday^{-1}animal^{-1} (g)	Avg. Lactation yield (litreday^{-1})	Avg. Lactation period(day)
Controlled Cattle	10	85-90	1.55	175
Dewormed Cattle	10	110-125	2.20	188
Dewormed+ Vitamin feeding treated Cattle	10	140-160	2.65	210

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

The performance of body weight gain, milk production and laction period after deworming and vitamin ADE injection are presented in Table 11.38.4. It was indicated that maximum body weight gain (165-175 g day^{-1} $animal^{-1}$), milk production (2.55 L day^{-1}) and lactation period (215 days) was obtained from deworming and vitamin ADE injection treated cattle followed by dewormed cattle and minimum from controlled cattle (Avg. 3 years).

Picture 11.78. Cattle health improvement by deworming and vitamin ADE injection at FSRD site Atia, Tangail

Table 11.38.4. Average body weight gain, milk production and lactation period after deworming at FSRD site, Atia, Tangail during 2018 to 2021

Treatment	No. of animal	Avg. Body wt. gain $day^{-1}animal^{-1}$(g)	Avg. Lactation yield (litre day^{-1})	Avg. Lactation period (day)
Controlled Cattle	06	75-80	1.60	170
Dewormed Cattle	06	120-130	2.10	195
Dewormed + Vitamin ADE injection treated Cattle	06	165-175	2.55	215

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur (BARI)

Deworming technology are encouraging on cattle health and found easy to adopt with minimum cost involvement. That's why the cooperator farmers were interested in adopted this technology as per routine work. The performance of body weight, milk production and lactation period after deworming are presented in Table 11.38.5. The maximum body weight gain (60-75 g day^{-1} $animal^{-1}$), milk production (1.5 L day^{-1}) and lactation period (205 days) were obtained from dewormed cattle and minimum from controlled cattle (Avg. 3 years).

Picture 11.79. Cattle health improvement by deworming at FSRD site Tarakandi, Sherpur

Table 11.38.5. Average body weight gain, milk production and lactation period after deworming at FSRD site, Tarakandi, Sherpur during 2018 to 2021

Treatment	No. of animal	Avg. Body wt. gain $day^{-1}animal^{-1}$ (g)	Avg. Lactation yield (litter day^{-1})	Avg. Lactation period (day)
Controlled Cattle	12	25-30	1.2	180
Dewormed Cattle	30	60-75	1.5	205

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.39. Improvement of health condition of cattle through de-worming at FSRD Site Mokamia, Fulpur. Mymensingh (BFRI)

Initial average body weight of control cattle and de-wormed cattle were 123 kg and 120 kg, respectively. After six months, the final weight of control cattle and de-wormed cattle were 128 kg and 136 kg, respectively (Table 11.39.1). A remarkable difference of body weight was observed with "Endex bolus". The body weight gained of treated cattle and controlled cattle were 16.0 and 5.0 kg, respectively. Through this program, farmers are able to understand the advantage of de-worming in cattles.

Table 11.39.1. After six months average body weight gained (kg) of de-wormed cattle at FSRD Site Mokamia, Fulpur. Mymensingh

Parameters	Initial body weight (kg)	Final body weight (kg)	Average body weight gained (kg)
Controlled	123±5.21	128±4.20	5.0
Treated	120±7.20	136±5.48	16.00

Farmer's reaction

(i) Farmer's are very interested to de-wormed their animal.
(ii) Feed intake of animal increase day by day.
(iii) Skin color bright up for this.
(iv) Milk production and lactation length increase in dairy cattle.
(v) Before de-worming the animals was less body weight, loss of appetite and emaciated.
(vi) After de-worming the body weight of animals was increased.

11.40. Cattle fattening program at different FSRD sites during 2018 - 2021

FSRD site: Ajoddhapur Rangpur (BARI)

Cattle were dewormed and vaccinated under beef fattening program and supplied balance and improve feed. It was found that body weight of cattle under the program, increased rapidly (Table 11.40.1.). Body weight of each cattel was increased over initial on and average 46%. Market value of each cattle was increased on an average 65%.

Picture 11.80. Cattle fattening program at FSRD site Ajoddhapur Rangpur

Table 11.40.1. Body weight gain and market value of cattle under beef fattening program at FSRD site Ajoddhapur Rangpur during 2018-2021

Year	No. of cattle	Initial body wt. (kg)	Body wt. after 90 days (kg)	Body wt. increase over Initial (%)	Initial value (Tk.)	Present value (Tk.)	Market value Increment (%)
Year I	1	56	70	25	22000	32000	45.45
Year II	3	32	48	50	18000	33000	83.33
Year III	2	60	98	63	15000	25000	66.67
Average	2	49	72	46	18333	30000	65.15

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna (BARI)

Beef fattening program was conducted during three consecutive years. Fourteen cooperator farmers were selected for beef fattening program during the years of 2018 to 2021. Cattle were dewormed and vaccinated under beef fattening program and supplied balance and improved feed. It was found that average body weight increased over initial bdy weight (42-134%) due to fattening program. Market value was estimated and increased around 77-197% as compared initial value of the cattle (Table 11.40.2).

Table 11.40.2. Body weight gain and market value of cattle under beef fattening program at FSRD site Ganggarampur, Pabna during 2018 to 2021

Year	Farmer	No. of cattle	Initial body wt. (kg)	Body wt. after 180 days (kg)	Body wt. increased over initial (%)	Initial value (Tk.)	Present value (Tk.)	Market value increased (%)
Year I	Farmer-1	2	285	415	46	62300	140200	125
	Farmer-2	1	177	297	68	58500	103500	77
	Farmer-3	1	212	342	61	59300	115500	95
Year II	Farmer-1	2	301	482	60	60500	160600	165
	Farmer-2	1	255	362	42	52000	125500	141
	Farmer-3	2	180	315	75	56500	112000	98

Year	Farmer	No. of breed	Initial body wt. (kg)	Body wt. after 180 days (kg)	Body wt. increased over initial (%)	Initial value (Tk.)	Present value (Tk.)	Market value increased (%)
Year III	Farmer-1	1	145	250	72	49600	92500	86
	Farmer-2	2	160	375	134	44000	130500	197
	Farmer-3	2	163	292	79	48500	102300	111

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

Under beaf fattening program calf was dewormed, vaccinated and supplied balance and improve feed. It was found that body weight of calf under the program, increased rapidly. (Table 11.40.3). Body weight increased over initial from 24 to 32%. At the same time, market value of each cattle was increased about 56 to 66%.

Table 11.40.3. Body weight gain and market value of cattle under beef fattening program at FSRD site, Atia, Tangail during 2018 to 2021

Year	No. of cattle	Initial body wt. (kg)	Body wt. after 90 days (kg)	Body wt. increase over Initial (%)	Initial value (Tk.)	Present value (Tk.)	Market value increment (%)
Year I	1	120	154	28	36000	56000	56
Year II	1	116	144	24	35000	55000	57
Year III	1	128	169	32	38000	63000	66
Average	1	121	156	28	36333	58000	60

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur (BARI)

The program was started at May 2020 and continued up to Jan. 2021. One cattle were included in this program. Initial body weight of the cattle was 82 kg. After 6 months of rearing body weight gained 107 kg due to improved feed management and vaccination (Table 11.40.4). Body weight was increased over initial 30%. At the same time, market value of cattle was increased about 28 %.

Picture 11.81. Cattle fattening program at FSRD site Tarakandi, Sherpur

Table 11.40.4. Body weight gain and market value of cattle under beef fattening program at FSRD site Tarakandi, Sherpur

Year	No. of cattle	Initial body wt. (kg)	Body wt. after 180 days	Body wt. increase over initial (%)	Initial value/ cattle (Tk.)	Present value/ cattle (Tk.)	Market value increment (%)
Year III	1	82	107	30	37000	47500	28

* Year III= Feb.2020- Jan.2021

11.41. Cattle fattening program at FSRD site Tengra, Sreepur, Gazipur during 2018 - 2021

Initial body weight of each cattle was 48-130 kg. After six month of rearing, body weight increased over initial from 44 to 64%. At the same time, market value of each cattle was increased about 50 to 88% (Table 11.41.1).

Picture 11.82. Cattle fattening program at FSRD site Tengra, Sreepur, Gazipur

Table 11.41.1. Body weight gain and market value of beef fattening program at FSRD site Tengra, Sreepur, Gazipur during 2018-2021

Farmer's Name	No. of cattle	Initial body wt. (kg)	Body wt. after 180 days (kg)	Body wt. increase over Initial (%)	Initial value (Tk.)	Present value (Tk.)	Market value increment (%)
Abdus Sattar	1	32	48	50	18000	33000	83
Abdul Karim	1	65	96	48	28000	42000	50
Alauddin	1	28	46	64	16000	28000	75
Borhan Uddin	1	90	130	44	30000	45000	50
Nazim Uddin	1	30	45	50	17000	32000	88

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.42. Calf rearing program at FSRD sites of BARI during 2019 to 2021

FSRD Site: Ganggarampur, Pabna (BARI)

A total of eight calves were selected for rearing (Table 11.42.1). Age and initial body weight of calf were little differed among the cooperator farmers. However, feed management was done as per consultation with the livestock personnel. The selected calves were gradually gained body weight. The range of increase in body weight of calf was recorded 50-188 kg. This variation in increase of body weight might be due to differences of calf age, feed intake and nursing.

Picture 11.83 Calf rearing program at FSRD site Ganggarampur, Pabna

Table 11.42.1. Calf rearing performance at FSRD site, Ganggarampur, Pabna during 2019 to 2021

Name of farmers and address	No. of calf	Breed	Date of initiation	Age during iniation	Initial weight (kg)	Year II		Year III	
						Present weight (kg) 29.4.19	Weight increased (kg)	Present weight (kg) 20.12.20	Weight increased (kg)
1. Md Akul Sordar Pirpur	1	Cross breed	14.11.19	3 months	44	67	23	112	68
2. Md. Abdul Baki Pirpur	1	Cross breed	14.11.19	5 months	75	112	37	125	50

Name of farmers and address	No. of calf	Breed	Date of initiation	Age during iniation	Initial weight (kg)	Year II		Year III	
						Present weight (kg) 29.4.19	Weight increased (kg)	Present weight (kg) 20.12.20	Weight increased (kg)
3. Md. Jilal	1	Freejian	14.11.19	2 months	46	120	74	234	188
Pirpur	1	Jursey	14.11.19	8 months	82	144	62	263	181
4. Md. Altaf	1	Sahiwal	14.11.19	6 months	104	141	37	170	66
Pirpur	1	Freejian	14.11.19	7 months	95	160	65	192	97
5. Md. Sadek Ali Kasarpur	1	Local	14.11.19	8 moths	76	138	62	165	89
6. Md. Abdul Molla Kasarpur	1	Local	14.11.19	8 months	67	95	28	120	53

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.43. Goat rearing in the farmer's household for increasing income

FSRD Site: Tarakandi, Sherpur (BARI)

Goats were supplied among 7 farmers at FSRD site, Tarakandi, Sherpur. Each farmer received one female goat. Average initial body weight of the supplied goat was 9.5 kg. Survival rate of the supplied goat was 100% (Table 11.43.1). Body weight gained each year up to six months of rearing 4.0 kg and 5.0 kg, respectively. Average kids was born 3 per farmer during Feb. 2019- Jan. 2021. Gross margin from farmer-1 was calculated 2033 and Tk. 2460 during February 2019-January 2020 and February 2020-January 2021, respectively.

Picture 11.84. Goat rearing program at FSRD Site: Tarakandi, Sherpur

Table 11.43.1. Performance of goat rearing program at FSRD site, Tarakandi, Sherpur during 2019 to 2021

Item	February 2019-January 2020	February 2020-January 2021
Number of farmers	3	4
Number of goats distributed farmer^{-1}	1	1
Date of distribution	November	October
Age of goat during distribution	13 months	13 months
Initial body wt.goat^{-1} (kg)	10 .0	9.0
Procurement price goat^{-1} (Tk.)	4000	3500
No of goat survive	100%	100%
Wt. gained goat^{-1} after 6 months (Kg)	4.0	5.0
Total number of kids born (Feb. 19- Jan. 21) farmer^{-1}	4	2
Total return (Tk.) farmer^{-1}	6033	5960
Total variable cost (Tk.) farmer^{-1}	4000	3500
Gross margin (Tk.) farmer^{-1}	2033	2460

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD site: Sreepur, Gazipur (BRRI)

Three to four months aged goat were distributed among five farmers. Average initial body weight of goat was 3.5 kg. Body weight was gained 9 kg, 15 kg and 22 kg during 1st, 2nd and 3rd year respectively, up to six months of rearing. Average two kids were born (2018-2021) per goat. Average gross return and gross margin per farmer were calculated Tk. 6600 & 4500 in the year II & Tk. 13600 and Tk. 7100 in the year III, respectively (Table 11.43.2).

Table 11.43.2. Performances of goat rearing program at FSRD site Sreepur, Gazipur during 2018 to 2021

Description of Item	Year I	Year II	Year III
Number of farmers	5	Continued	Continued
No. of goat supplied farmers^{-1}	1	-	-
Date of supplied	12 November 2018	-	-
Age of goat during distribution	3-4 months	-	-
Initial body wt goat^{-1} (kg)	3.5	-	-
Procurement price goat^{-1} (Tk.)	2200	-	-
No of goat survive	5	3	2
Weight gained goat^{-1} (Kg) after 6 months	9	15	22
Total number of kids born (Feb.2018-Dec. 2020) per farmer	2		
Total return in Tk. farmer^{-1} (Kids + Adults)	-	6600	13600
Total variable cost (Tk.) farmer^{-1}	300	2100	6500
Gross margin (Tk.) farmer^{-1}	-	4500	7100

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.44. Performance of Turkey at farmer's level for egg and meat purpose

FSRD site: Ajoddhapur, Rangpur (BARI)

Among the twelve cooperators farmers, twelve Turkey birds in 2019-20 and 5 birds in 2020 were distributed per household (Table 11.44.1). The average body weight gained from those Turkey birds was about 4.65 kg (after 5 months). The average gross margin was obtained Tk. 6700. per family after five months rearing of turkey.

Picture 11.85. Turkey rearing program at FSRD site: Ajoddhapur, Rangpur

Table 11.44.1. Average performances of Turkey at farmers' level up at 12 months of rearing at FSRD site Ajoddhapur, Rangpur during 2019 to 2021

Item	February 2019 – January 2020	February 2020 – January 2021	Average
Number of farmers	12	12	12
No of birds supplied	144	60	102
No of birds survived	141	58	99.5
Age of supplied bird (days)	45	46	45.5
Initial wt.bird^{-1} (kg)	0.25	0.3	0.28
Initial value bird^{-1} (Tk.)	200	200	200
Rearing period (month)	5	5	5

Year	February 2019 – January 2020	February 2020 – January 2021	Average
Feed supplements bird^{-1}day^{-1} (g)	40	40	40
Feed supplements cost bird^{-1}(Tk.)	300	300	300
Present wt.bird^{-1} (kg)	4.75	5.1	4.93
Weight gained bird^{-1} (kg)	4.5	4.8	4.65
Gross return (Tk.Family^{-1})	11500	5000	8250
Total cost (Tk.Family^{-1})	1600	1500	1550
Gross margin (Tk.Family^{-1})	9900	3500	6700

FSRD site: Sreepur, Gazipur (BRRI)

During first year 54 chicks were distributed to one farmer, in the second year 70 chicks were distributed among seven farmers and in the third year 35 chicks were distributed to one farmer. Turkey started laying eggs after rearing of 5 months. Farmers sold and hatched egg on an average 35% and 45%, respectively. About 15% eggs were damaged during hatching. Chicks from hatching eggs were sold in the market. Farmers earned money from selling of eggs, chicks and adult birds. Maximum income was obtained from selling adult birds followed by turkey chicks and eggs. Gross margin was earned from turkey rearing Tk. 269650, Tk. 350545 and Tk. 141550 during 1st, 2nd and 3rd year, respectively (Table 11.44.2). Farmers were highly interested to include this new intervention in their existing farming practice because turkey rearing under scavenging system is easy, farmers friendly and profitable.

Table 11.44.2. Average performances of Turkey at farmers' level up at 12 months of rearing at FSRD site Sreepur, Gazipur during 2018 to 2021

Item	Year 1	Year II	Year III
Number of farmers	1	7	1
No of birds supplied	54	70	35
Date of supplied period	23-04-2018	07-01-2019	23-02-2020
Initial body wt. bird^{-1} (kg)	80-90	75-90	80-90
Procurement price bird^{-1} (Tk.)	370	350	300
No of chick survive	50	65	34
Date of egg delivery	27-09-2018	27-06-2019	20-07-2020
Egg Production (Number)	1330	1200	840
Consumption	28	40	36
Sale	1031	804	572
Distribution	16	24	08
Hatched	200	260	180
Damaged	55	72	44
Total number of Egg	1330	1200	840
Performance of Bird			
Weight gained/bird (Kg)	7.2	7.0	7.1
Consumption	8	10	5
Sale	116	200	85
Distribution	1	0	0
Total number	125	210	90
Total income from bird (Tk.)	287500	420000	162000

Year	Year 1	Year II	Year III
Total variable cost (Tk.)	92000	119600	75000
Total return farmer^{-1} in Tk. (Market value of Egg+ Chick+ Adult bird)	361650	470145	216550
Gross margin (Tk.)	269650	350545	141550

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Picture 11.86. Turkey rearing program at FSRD site Sreepur, Gazipur

11.45. Performance of Sonali chicken at different FSRD sites during 2018 - 2021

FSRD Site: Ganggarampur, Pabna (BARI)

Five to twelve farmers were selected for poultry rearing and each farmer was supplied 25 number of Sonali chicks (ratio between male and female is 1:9) which was purchased from Poultry Farm. BCRDV and booster dose of BCRDV vaccine was provided in schedule time and Gumboro vaccine was provided at due time. The family members constructed a small house (5ft x 8ft) with bamboo, tin or wood near their own living house. The initial weight of Sonali breed provided to the cooperator farmer was about 0.6-0.72 kg and average final body weight of those chickens was about 1 to 1.5 kg. It was found that gross margin per farm was Tk. 5150-28700 (Table 11.45.1). Farmers showed their interest in rearing Sonali chicken because of better production of egg and meat.

Picture 11.87 Sonali chicken rearing at FSRD Site, Ganggarampur, Pabna

Table 11.45.1. Performance of Sonali chicken rearing at FSRD Site, Ganggarampur, Pabna during 2018 to 2021

Description of Item	Year I	Year II	Year III	
			1st package	2nd package
Number of farmers	12	5	5	3
No. of bird supplied	300	125	125	75
Date of supplied period	1.11.18 to 27.1.19	4.11.19	4.11.19	30.6.20
Initial body weight (kg)	0.6	0.72	0.72	0.70
Procurement price bird^{-1} (Tk.)	35	180	180	180
No. of chicken survived	280	21	21	22
Date of delivery egg	-	-	5.1.20 to 20.12.20	10.12.20
Egg production (number)	-	-	5150	240
Consumption	-	-	1320	32
Sale	-	-	3780	204
Distribution	-	-	50	4
Total number of eggs	-	-	5150	240
Performance of bird		-		
Weight gained bird^{-1} (kg)	1.04	0.380	1.58	1.00

Description of Item	Year I	Year II	Year III	
			1st package	2nd package
Consumption	21	-	-	-
Sale	257	-	-	-
Distribution	2	-	-	-
Total number	280	-	-	-
Total income from bird (Tk.)	-	-	7250	5950
Total return farm^{-1} in Tk. (Egg &Meat)	59200	-	58750	13500
Total variable cost (Tk.)	30500	-	50950	8350
Gross margin	28700	-	7800	5150

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD site Sholakundu, Faridpur (BARI)

Twelve farmers were selected at the FSRD Site for poultry rearing and each farmer was supplied 10 number of Sonali chicks (ratio between male and female is 1:9) which was purchased from Poultry Farm. BCRDV and booster dose of BCRDV vaccine was provided in schedule time. The family members constructed a small house (5ft x 8ft) with bamboo, tin or wood near their own living house. Twenty (20) kg initial feed, one feed pot and one water pot were supplied to the farmer at the time of chick supply. The birds were also vaccinated timely and treated against different diseases. It was found that initial body weight was 0.69-0.72 kg per bird which after 160-163 days raised to 1.01-1.16 kg, respectively. Number of eggs per bird was given 38-133 and total value of egg per bird was Tk. 380-1330. The average consumption of eggs per farm family was 52 during laying period up to January 2021. It was found that total return per farm was Tk. 7170-8568 and gross margin was Tk. 4151-4165 (Table 11.45.2). Farmers showed their interest in rearing Sonali chicken for their growth and number of egg production.

Picture 11.88. Sonali chicken rearing at FSRD site Sholakundu, Faridpur

Table 11.45.2. Average performance of Sonali chicken rearing upto 12 months at FSRD site Sholakundu, Faridpur during 2018 to 2021

Description of item	Year I	Year II	Year III
Number of farmers	12	12	12
No of birds supplied (3 times)	120	120	120
Date of supplied period	9 Oct 2019	15 Mar 2020	10 Sep 2020
Initial body wt.bird^{-1} (kg)	0.69-0.72	0.70	0.66
Procurement price bird^{-1} (Tk.)	138	140	148
No of chicken survivefarm^{-1}	4	5	6
Date of delivery egg	18.2.19 to 15.12.20	27.6.2020 – 15.12.2020	-
Egg Production (Number of eggbird^{-1})	--	76	-
Consumption	346	281	-
Sale	170	85	-
Distribution	16	12	-
Total number of egg farm^{-1}	532	378	-
Performance of Bird	--	--	-
Weight gained/bird (kg)	1.16	1.01	-
Consumption (kg)	2.25	4.00	-
Sale (kg)	7.00	19.94	-
Distribution (kg)	--	--	-
Total weight (kg)	9.25	23.94	-
Total return farmer^{-1} in Tk.(Market value of egg + meat)	7170	8568	-
Total variable cost (Tk.)	3005	4417	-
Gross margin (Tk.)	4165	4151	-

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

Ten farmers were selected at the FSRD Site for poultry rearing and each farmer was supplied 10-20 number of Sonali chicks (ratio between male and female is 1:9) which was purchased from Poultry Farm. BCRDV and booster dose of BCRDV vaccine was provided in schedule time and gumboro vaccine was provided at due time. The family members constructed a small house (5ft x 8ft) with bamboo, tin or wood near their own living house. Twenty (20) kg initial feed, one feed pot and one water pot were supplied to the farmer at the time of chick supply. The birds were also vaccinated timely and treated against different diseases. It was found that initial body weight was 0.57-0.58 kg per bird which after 8 months raised to 2.10-2.38 kg, respectively. Number of eggs per bird was given 40-92 and total value of egg per bird was Tk. 400-920. The average consumption of eggs per farm family was 74 during laying period. It was found that total return per farm was Tk. 11967-16929 and gross margin was Tk. 4822-11784 (Table 11.45.3). Farmers showed their interest in rearing Sonali chicken for their growth and number of egg production.

Table 11.45.3. Average performance of Sonali chicken rearing upto 12 months at FSRD site, Atia, Tangail during 2018 to 2021

Description of Item	Year I	Year II	Year III
Number of farmers	10	10	10
No of birds supplied	100	200	100
Date of supplied period	18.10.2018	18.06.2019	12.03.2020
Initial body wt.bird^{-1} (kg)	0.57	0.58	0.57
Procurement price bird^{-1} (Tk.)	200	180	190
No of chicken survive	92	190	85
Date of delivery egg	23.12.18 to 01.02.19	23.10-19 to 31.01.20	15.09.20 to 15.12.20
Egg Production (Number of eggbird^{-1})	40	90	92
Consumption	56	128	133
Sale	258	487	591
Distribution	06	15	12
Total number of egg farm^{-1}	320	630	736
Performance of Bird			
Weight gained bird^{-1} (kg)	2.10	2.38	2.12
Consumption	02	02	01
Sale	07	07	07
Distribution	0	0	0
Total number	9	9	8
Total income (Tk.) from bird farm^{-1}	2064	3896	4728
Total variable cost (Tk.) farm^{-1}	7145	5145	5318
Total return farm^{-1} in Tk. (Market value of egg + meat)	11967	16929	14967
Gross margin (Tk.)	4822	11784	9649

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sreepur, Gazipur (BRRI)

Twelve farmers were selected for rearing of Sonali chicken and each farmer was distributed 20, 30 and 40 number of Sonali chicks in the 1st, 2nd and 3rd year, respectively. BCRDV and booster dose of BCRDV vaccine was provided in schedule time and gumboro vaccine was provided at due time. The average initial body weight of sonali chicks was 60-70 g during distribution. Body weight increased after six months were 1.14 kg, 1.25 kg and 1.32 kg in three consecutive years, respectively. Average gross return per farmer was 67600, 82300 and Tk. 101500, respectively in three consecutive years. Average gross margin per farmer in 1st, 2nd and 3rd year were recorded 49300, 56700 and Tk. 67500, respectively (Table 11.45.4). The egg consumption rate was increased among family members as well as nutritional intake was also increased.

Table 11.45.4. Average performance of Sonali chicken after 6 months of rearing at FSRD site Sreepur, Gazipur during 2018 to 2021

Description of Item	Year I	Year II	Year III
Number of farmers	12	12	12
No of birds supplied farmer^{-1}	20	30	40
Date of supplied period	03-10-2018	14-07-2019	25-06-2020
Initial body wt. bird^{-1} (kg)	60-70	60-70	60-70
Procurement price bird^{-1} (Tk.)	18	20	20
No of chicken survive farmer^{-1}	18	28	37
Weight gained bird^{-1} (Kg) after 6 months	1.14	1.25	1.32
Consumption	32	70	85
Sale	186	264	370
Total number	218	334	445
Total return farmer^{-1} in Tk. (Market value of Egg + Meat)	67600	82300	101500
Total variable cost farmer^{-1} (Tk.)	18300	25600	34000
Gross margin farmer^{-1} (Tk.)	49300	56700	67500

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Picture 11.89. Sonali chicken Rearing at FSRD site Sreepur, Gazipur

FSRD Site: Mokamia, Fulpur, Mymensingh (BFRI)

Five farmers were selected for rearing of Sonali chicken and each farmer was distributed 10 number of Sonali chicks. The average initial body weight of sonali chicks was 80-90 g during distribution. The average monthly egg production and consumption/family were 171 and 50, respectively. The egg size was bigger in Sonali hens than indigenous hens. The monthly average egg production was highest in F4 and lowest in F5. On an average 29.24% egg were consumed/farm family. The average egg production cost was Tk. 663/family. The average monthly gross return from eggs was Tk. 1370 family^{-1}. The average monthly gross income from egg of Sonali chicken (from within 10 nos.) was Tk. 707 (Table 11.45.5).

From the results, it is evident that through farming Sonali chicken, average monthly gross income from egg production farm family^{-1} increased.

Picture 11.90. Sonali chicken rearing at FSRD site Mokamia, Fulpur, Mymenshin

Table 11.45.5. Egg production, egg consumption and income from Sonali chicken rearing at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Farmers						Average
	F_1	F_2	F_3	F_4	F_5	F_6	
No. of chicken	10	10	10	10	10	10	10
Average egg production month^{-1} family^{-1} (nos.)	180	172	160	186	156	174	171
Average egg consumption month^{-1} family^{-1} (no.)	52	62	48	56	40	46	50
Average cost month^{-1} (Tk.)	680	674	685	602	675	665	663
Average gross return month^{-1} (Tk.)	1441	1376	1280	1488	1248	1392	1370
Average grosse margin month^{-1}h (Tk.)	761	702	595	886	573	727	707

* Price of egg: Tk.8 / egg

11.46. Performance of Naked neck (Garchila) chicken during 2018 -2021

FSRD Site: Tarakandi, Sherpur (BARI)

Initial average weight of naked neck chick was recorded as about 671 g which was increased to an average of about 1.60 kg after 6 months of rearing. Average egg production per bird was 86. From cost analysis, gross margin (Avg. 3 year) was calculated as Tk. 3408 farm family^{-1} (Table 11.46.1). Farmers opined that naked neck chick rearing in the semi-scavenging system under village condition is economically viable and it can be strongly recommended for large scale extension to the farmers' level.

Picture 11.91. Naked neck (Garchila) chicken rearing at FSRD site Tarakandi, Sherpur

Table 11.46.1. Performance of naked neck chicken rearing at FSRD site, Tarakandi, Sherpur during 2018 to 2021

Item	Year I	Year II	Year III
Number of farmers	8	12	12
Number of birds supplied farmer^{-1}	10	5	5
Date of supplied period	20.09.2018	01.10.2019	01.2.2020
Initial body wt.bird^{-1} (kg)	0.65	0.69	0.69
Procurement price chicken^{-1} (Tk.)	250	220	220
No. of chicken survive	70	58	55
Wt. of bird^{-1} after 6 months	1.62	1.54	1.65
Consumption (meat no. of hen)	8	8	12
Consumption (egg no.)	88	70	28
Sale (hen no.)	5	12	26
Sale (egg no.)	325	212	72
Distribution (egg no.)	15	18	12
Total gross return in (Tk. (Egg+ Meat) farmer^{-1}	6180	5122	6163
Total variable cost (Tk.) farmer^{-1}	3000	2050	2190
Gross margin (Tk.) farmer^{-1}	3180	3072	3973

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.47. Performance of Khaki Campbell duck at different FSRD sites of BARI during 2018 - 2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Among the twelve, three farmers were reared duck in their homestead using their pond. The average egg laid by the duck 120-210 no. month^{-1} household^{-1} (Table 11.47.1). Consumption of egg was 60-65 numbers after starting the duck rearing. Monthly income was calculated about Tk. 1200-2000 month^{-1} household^{-1}.

Table 11.47.1. Performance of Khaki Campbell duck after 6 months of rearing at FSRD Site Ajoddhapur, Rangpur during 2018 to 2021

Name of Farmer	No. of ducks survived at present	Body wt. after 6 months (kg)	Production of egg month^{-1}	Consumption of eggs month^{-1}		No. of egg laid month^{-1}	Monthly income (Tk.)
				Before	After		
Farid Ali	9	1.1	180	0	60	180	1800
Kismot	10	1.12	200	0	65	200	2000
Keramot Ali	6	1015	120	0	62	120	1200
Average	8	339	167	0	62	167	1670

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

Eight farmers were selected for duck rearing. Each farmer was given 10 ducks of 4-months old. Average survival rate of duck was 75% (Table 11.47.2). The ratio of male and female was 1:5. The results showed that ducks started lying egg after six months of age and average production was 25 eggs month^{-1} duck^{-1}. Each farm family has gained more than 160 eggs from a month (25 eggs month^{-1} duck^{-1}). On an average, it was observed that the cooperative farmers sold some eggs and earned Tk. 1680 month^{-1} farm^{-1}. The average consumption of eggs per farm family was 25 after rearing and it was only 12 before rearing. The consumption rate of egg per farm family was increased due to laying egg of their own ducks.

Picture 11.92. Duck rearing program at FSRD site Atia, Tangail

Table 11.47.2. Performance of Khaki Campbell duck after 6 months of rearing at FSRD site, Atia, Tangail during 2018 to 2021.

Year	No. of Farmer	No. of ducks survived at present	Body wt. after 6 months (kg)	Production of egg monthly^{-1} duck^{-1}	Consumption of egg month^{-1}		No. of egg laid month^{-1}	Monthly income farm^{-1} (Tk.)
					Before	After		
Year 1	04	33	2.95	24	12	20	672	1680
Year II	10	100	3.25	26		30	2210	1800
Year III	10	92	3.16	24		25	1920	1560
Average	8	75	3.12	24.67	12	25	1601	1680

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.48. Performance of Jinding duck at different FSRD sites during 2018 - 2021

FSRD Site: Tarakandi, Sherpur (BARI)

Initial average weight of Jinding breed was recorded as about 750 g which was increased to an average of about 1.69 kg after 6 months of rearing (Table 11.48.1) Average egg production per bird was 72 number. Average monthly income from egg seling Tk. 1103 farm family^{-1}. Egg laying capacity also increased significantly as a consequence of proper feeding and management. Farmers showed their keen interest for

rearing of Jinding breed both meat and egg purpose. Farmers especially women and children expressed satisfaction of duck rearing by improved rearing system and commercially profitable.

Table 11.48.1. Performance of Jinding breed duck after 6 months of rearing at FSRD Site, Tarakandi, Sherpur during 2018 to 2021.

Name of Farmer	No. of ducks survived at present	Body wt. after 6 months (kg)	Egg production month^{-1}	Egg Consumption month^{-1}		No. of egg laid month^{-1}	Monthly income (Tk.)
				Before rearing	After rearing		
Md. Nurul Islam	9	1.69	102	10	25	102	1020
Md. Nur Islam	8	1.66	104	15	28	104	1040
Md. Tota mia	9	1.68	120	11	33	120	1200
Md. Nasmul Islam	10	1.72	115	18	34	115	1150
Average	*9*	*1.69*	*110*	*13.5*	*30*	*110*	*1103*

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Mokamia, Fulpur, Mymensingh (BFRI)

Five farmers were selected for rearing of Khaki Campbell duck and each farmer was distributed 10 numbers of duck. The average monthly egg production and consumption farm family^{-1} were 150 and 58, respectively (Table 11.48.2). The monthly average egg production was highest in F5 (166) and lowest in F4 (135). On an average 58 eggs were consumed farm family^{-1} after laying egg of their own ducks. The average egg production cost was Tk. 430 farm family^{-1} and average monthly gross return from eggs Tk. 922 farm family^{-1}. The average monthly income was highest in F1 and lowest in F2. The marginal farmers could rear this type of duck as it requires low initial investment with reasonable gross margin (Tk. 492 month^{-1}) of minimum risk.

Table 11.48.2. Egg production, egg consumption and income through Khaki Campbell duck rearing at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Farmers					Average
	F_1	F_2	F_3	F_4	F_5	
No. of duck	10	10	10	10	10	10
Average egg production family^{-1}Month^{-1} (nos.)	160	152	140	135	166	150
Average egg consumption family^{-1} month^{-1} (no.)	60	72	50	40	70	58
Average gross return (Tk.) month^{-1}	1000	800	900	950	960	922
Total average cost (Tk.) month^{-1}	500	400	500	450	300	430
Average gross margin (Tk.) month^{-1}	500	400	400	500	660	492

* F indicates Farmer * Price of egg: Tk.10 / egg

Farmer's reaction:

- Interested to rear the duck
- Market demand of egg is high
- Income increased

Picture 11.93. Duck rearing program at FSRD site Mokamia, Fulpur, Mymenshing

11.49. Egg production performance of Jinding duck in farmers household level

FSRD Site: Mokamia, Fulpur, Mymensingh (BFRI)

Five farmers were selected for rearing of Jinding duck and each farmer was distributed 10 number of duck. Average monthly egg production and consumption family^{-1} were 137 and 30, respectively (Table 11.49.1). The monthly average egg production was highest in F2 and lowest in F1. The average monthly gross margin from eggs was Tk. 970 family^{-1}. In comparison to indigenous and Jinding duck (from within 10 nos.), average monthly gross margin were Tk. 536 and Tk. 970, respectively. The results also revealed that, average monthly egg production and gross margin per farm family increased by 51.50 and 44.74%, respectively through farming of Jinding duck than indigenous duck (Table 11.49.2).

Table 11.49.1. Egg production, egg consumption and income from Jinding duck rearing at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Farmers					Average
	F_1	F_2	F_3	F_4	F_5	
No. of duck	10	10	10	10	10	10
Average egg production month^{-1} (nos.)	180	220	200	210	190	200
Average egg consumption month^{-1} Family^{-1} (no.)	25	28	20	32	26	26
Average cost month^{-1} (Tk.)	750	720	710	730	760	734
Average gross return month^{-1} (Tk.)	1800	2200	2000	2100	1900	2000
Average gross margin month^{-1} (Tk.)	1050	1480	1290	1370	1140	970

* F indicates Farmer * Price of egg: Tk.10 / egg

Table 11.49.2. Comparative profitability analysis of rearing indigenous and jinding ducks before and after intervention at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Before Intervention (Indigenous)	After Intervention (Jinding)	% increased
Average egg production month^{-1}	132	200	51.50
Average cost (Tk.) month^{-1}	520	734	-
Average gross return (Tk.) month^{-1}	1056	2000	45.99
Gross margin (Tk.) month^{-1}	536	970	44.74

11.50. Performance of pigeon rearing at different FSRD sites during 2018 -2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Pigeons were distributed among twelve cooperators farmers, on-test basis two pairs per household and thereafter four pairs during 2019-20 (Table 11.50.1). The average weight per bird during supply period was on an average 180 g. The average squab production per family was 54 and intake of squab by the household family was 13. The average income from pigeon rearing was Tk. 1250 household-1.

Picture 11.94. Pigeon rearing program at FSRD site Ajoddhapur, Rangpur

Table 11.50.1. Performance of pigeon rearing program at FSRD site Ajoddhapur, Rangpur during 2019 to 2021

Year	No. of Pigeon Family^{-1}	Average weight (g)	No. of Squab Born	Pigeon died	Squab Intake	Sell	Cash income (Tk.)
Year-II	12	0.16	48	3	12	4	500
Year-III	12	0.20	60	3	14	16	2000
Average	12	0.18	54	3	13	10	1250

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna (BARI)

Every year two farmers who have around 16-30 pigeon per farm were selected for rearing of pigeon. Optimum feed management and other nursing was provided pigeon rearing. The body weight of pigeon provided to the cooperator farmer was about 170-210 g and each family get 20-65 squab per year. It was found that income per family from rearing pigeon was recorded Tk. 2160 to 5760 (Table 11.50.2).

Table 11.50.2. Performance of pigeon rearing at FSRD site, Ganggarampur, Pabna during 2018 to 2021.

Year	Farmes	No. of pigeonFmily^{-1}	Average weight (gm)	No. of Squab born	No. of pigeon died	No. of pigeon Consumed	No. of pigeon Selling	Income (Tk.)
Year-I	Farmer-1	30	180	65	10	20	37	4440
	Farmer-2	30	180	50	12	28	18	2160
Year-II	Farmer-1	28	170	60	6	18	48	5760
	Farmer-2	28	170	66	5	28	41	5330
Year-III	Farmer-1	16	210	26	2	14	20	2500
	Farmer-2	20	200	22	2	6	24	3050

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi Sherpur (BARI)

Pigeon were supplied 4 farmers with 2 pair pigeon. Average weight of the supplied pigeon was 190 g. Average nine pairs of squabs was born of four farmers after six month and the farmers kept them to add another pigeon pair and some of them were sold. Finally, total six pairs of squabs were borned per family. Before intervention the farmers have no pigeon and income. But due to rearing of pigeon, per farmer earned Tk. 1500 (Table 11.50.3).

Picture 11.95 Pigeon rearing program at FSRD site Tarakandi Sherpur

Table 11.50.3. Performance of pigeon rearing program at FSRD site, Tarakandi, Sherpur during 2020-2021

Year	No. of Pigeon Family^{-1}	Average weight (g)	No. of Squab born	Pigeon died	Squab Intake	Sell	Income (Tk.)
Year-III	2 pair	0.19	9 pair (Avg.)	Squab 3 (avg.)	3	12	1500

* Year III= Feb.2020- Jan.2021

FSRD Site: Sreepur, Gazipur (BRRI)

Pigeon were supplied 6 farmers with 2 pair of pigeon. Average body weight gain per pigeon was 738 g. Average squab production was 17 per farmer during 2019-21. Most of the farmers sold the squab in local market. They sold 60% and consumed 20% which increase their income and nutrition uptake. Pigeon rearing was profitable and it provides additional income of Tk. 2167 per farmer by squab production (Table 11.50.4).

Table 11.50.4. Performance of pigeon rearing program at FSRD site Sreepur, Gazipur during 2019 to 2021

Farmer	Pigeon no. Family^{-1}	Average body weight gained (g)	No. of squab	Squab intake	Sell	Income (Tk.)
Abdul Karim	4	730	20	5	9	2500
Abdus Sattar	4	700	12	3	6	1500
Borhan Uddin	4	750	14	2	6	1750
Nurul Hoque	4	755	18	2	7	2250
Rojab Ali	4	690	12	2	8	1500
Abul Kalam	4	800	28	4	8	3500
Average	4	738	17	3	7	2167

Squab price: Tk.200-250/pair

* Year II= Feb.2019- Jan.2020 and Year III= Feb.2020- Jan.2021

FSRD Site: Mokamia, Fulpur, Mymensingh (BFRI)

Results of pigeon farming of selected farmers are presented in Table 11.50.5. The average income from squab was Tk. 3240/5 pairs of pigeons. The average production of squabs was 18 pairs from 5 pairs of pigeon. The average squab production was highest in F2 and lowest in F4. Squabs were marketed as early as 17-20 days of age. The gross return and gross margin were recorded Tk. 3,240 and Tk. 2154, respectively through pigeon rearing per farm family after 7 month rearing of pigeon.

Picture 11.96. Pigeon rearing program at FSRD site Mokamia, Fulpur, Mymensingh

Table 11.50.5. Performance of pegion rearing program at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Farmers					Average
	F_1	F_2	F_3	F_4	F_5	
No. of pigeon (Pair)	5	5	5	5	5	5
Total no. of squabs born (Pair)	22	25	23	18	20	18
Average feed, vaccine, medicine cost (Tk.)	1200	1050	980	1000	1200	1086
Average gross return from squab (Tk.)/ 7 months	3300	3750	3450	2700	3000	3240
Average gross margin from squab (Tk.)/ 7 months	2100	2700	2470	1700	1800	2154

Farmer's reaction

- Easy and safest way of rearing
- Squabs born 7-8 Pair per year
- Lower disease susceptibility

11.51. Performance of green fodder production at different FSRD Sites

FSRD site: Ajoddhapur, Rangpur (BARI)

The production of Napier grass was 80 and 68 t ha^{-1} and the average gross margin was calculated Tk. 38000 and 2800 ha^{-1} in 2019-2020 and 2020-21, respectively (Table 11.51.1). The average green fodder yield was 74 t ha^{-1} and average gross margin was Tk. 33000 ha^{-1}.

Picure 11.97. Napier grass production program at FSRD site Ajoddhapur, Rangpur

Table 11.51.1. Average performances of Napier grass production at FSRD site Ajoddhapur, Rangpur during 2019-2021

Year	No. of harvesting	Green fodder yield (t ha^{-1})	Gross return (Tk.ha^{-1})	Total variable cost (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
Year II	17	80	80000	42000	38000
Year III	14	68	68000	40000	28000
Avg.	16	74	74000	41000	33000

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

Green fodder production in the homestead or nearby homestead area or road side was found as a promising technology for maintaining farmers own cattle as well as earning a handsome amount of money. On an average, six farmers were produced Napier grass as green fodder at FSRD site, Atia, Tangail during February 2019 to January 2021. The average green fodder yield was 32.22 t ha^{-1} obtained from 6 times harvest in a year with an average gross margin of Tk. 38447 ha^{-1} (Table 11.51.2).

Table 11.51.2. Average performances of Napier grass production at FSRD site, Atia, Tangail during 2018 to 2021.

Year	No. of farmers	No. of harvesting	Green fodder yield (t ha^{-1})	Gross return (Tk.ha^{-1})	Total variable cost (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})
Year II	05	3	33.90	84750	43390	41360
Year III	07	5	30.54	76350	40830	35520
Average.	06	4	32.22	80550	41000	38440

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.52. Performance of Farm Yard Manure production at FSRD Site during 2018 -2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Farm Yard Manure (FYM): Farm yard manure was produced by using cowdung and homestead wastage at the homestead area during the year of February 2018 to January 2021. The average production of FYM per homestead was 3050 kg and the gross margin was equivalent to Tk. 5400 $homestead^{-1}$ (Table 11.52.1).

Picture 11.98. Farm Yard Manure production program at FSRD site Ajoddhapur, Rangpur

Table 11.52.1. Compost production, utilization and income at FSRD site Ajoddhapur, Rangpur during 2018 -2021

Year	Total compost produce (kg homestead^{-1})	Use for crop production (kg farmer^{-1})	Distribution (kg farmer^{-1})	Sell (kg farmer^{-1})	Value of total compost produce per year (Tk. homestead^{-1})	TVC (Tk. Homestead^{-1})	Gross margin (Tk. homestead^{-1})
Year II	2200	2200	0	0	4400	500	3900
	3250	3000	0	250	6500	700	5800
Year III	2200	2200	0	0	4400	500	3900
	2850	2650	0	200	5700	700	5000
Avg.	2200	2200	0	0	4400	500	3900
	3050	2825	0	225	6100	700	5400

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.53. Performance of vermicompost production at FSRD sites during 2018 - 2021.

FSRD site: Ajoddhapur, Rangpur (BARI)

Vermicompost was produced with six farmers homestead area using cement ring. The average total vermicompost production was 320 kg homestead^{-1}. Gross margin was calculated Tk.840 homestead^{-1} after first time production (Table 11.53.1).

Picture 11.99. Vermicompost production program at FSRD site Ajoddhapur, Rangpur

Table 11.53.1. Vermicompost production, utilization and income at FSRD site Ajoddhapur, Rangpur

No. of Farmers	No. of ring homestead^{-1}	Total vermicompost produce (kg homestead^{-1})	Use for crop production (kg farmer^{-1})	Value of produce vermicompost year^{-1} (Tk.)	Total variable cost (Tk.homestead^{-1})	Gross margin (Tk.homestead^{-1})
6	2	320	320	2240	1400	840

D. Improvement of fisheries production system

11.54. Maximization of farmers' income through monoculture technique with high value fishes

FSRD site: Ajoddhapur, Rangpur (BARI)

i. Production program of Pabda fish

Pabda fish was cultured in one pond as a test case at FSRD site Ajoddhapur, Rangpur during 2018-19. Information on pond area, fry amount and weight, final total amount and number of fish, survival rate has been shown in Table 11.54.1.1. The pond was mostly seasonal, but water was supplemented for a certain duration. The pond was 8 decimals sized with approximately 3.0 m depth. The results revealed that, in Pabda fish culture the survival rate was 85%. Production and economic analysis are shown in Table 11.54.1.2. The production of fish was obtained 49 kg pond^{-1} with the gross margin Tk. 9550 pond^{-1}. Among the total production they consumed, distributed to relatives and sold their products in local market (Table 11.54.1.3). It was observed that, farmers sold most of the fish (61%), consumed about 35% and distributed about 4% through their neighbors, relatives and well-wishers of the produced fish. The fish feed price in the market is high, so, farmer was less interested to supplement feed through purchasing from the market. As a result, the production was relatively low.

Picture 11.100. Pabda Fish culture at FSRD site: Ajoddhapur, Rangpur

Table 11.54.1.1. Performance Pabda fish farming at FSRD site Ajoddhapur, Rangpur during 2018-2019

No. of pond	Area and depth of pond (dec. m)	Amount and number of fingerlings	Avg. weight of fingerlings (gm)	Final average weight of fish (g)	Total amount and number of fish	Survival rate (%)
1	08 dec. and 3m	7.6 kg #512	14.84	112	49 kg #435	85

Table 11.54.1.2. Production and Economics of Pabda farming at FSRD site Ajoddhapur, Rangpur during 2018-2019.

No. of pond	Total production (kg pond^{-1})	Total cost (Tk. pond^{-1})	Gross return (Tk. pond^{-1})	Gross margin (Tk. pond^{-1})	BCR
1	49	7600	17150	9550	2.26

Table 11.54.1.3. Utilization pattern of harvested Pabda fish at FSRD site Ajoddhapur, Rangpur during 2018-2019.

No. of pond	Total production (kg pond^{-1})	Consumption (kg)	Distribution (kg)	Selling (kg)
1	49	17	2	30

ii. Production program of Shing fish

Shing fish was cultured in three ponds as a test case at FSRD site Ajoddhapur, Rangpur during 2018-19. Information on ponds area, fingerlings amount and weight, final total amount and number of fish, survival rate has been shown in Table 11.54.2.1. The ponds were avg. 8.5 decimal sized with avg. 3.5 m depth. The results revealed that the avg. survival rate was 88%. Production, cost and return analysis are shown in Table 11.54.2.2. The production of fish was obtained 35.5 kg pond^{-1} with the gross margin Tk. 6125 pond^{-1}. Among the total production farmer consumed, distributed to relatives and sold their products in local market (Table 11.54.2.3). It was observed that, farmers sold most of the fish (65%), consumed about 27% and distributed about 8% through their neighbors, relatives and well-wishers of the produced fish.

Picture 11.101. Shing Fish culture at FSRD site: Ajoddhapur, Rangpur

Table 11.54.2.1. Performance of Shing fish farming at FSRD site Ajoddhapur, Rangpur during 2018-2019.

No. of pond	Area and depth of pond (dec. m)	Amount and number of fingerlings	Average weight of fingerlings (g)	Final average weight and length of fish (g and cm)	Total amount and number of fish	Survival rate (%)
3	8.5 dec. and 3.5 m	2.9 kg # 298	9.73	135g and 19 cm	35.5 kg #262	88

Table 11.54.2.2. Production and economics of Shing fish farming at FSRD site Ajoddhapur, Rangpur during 2018-2019.

No. of pond	Total production (kg pond^{-1})	Total cost (Tk. pond^{-1})	Gross return (Tk. pond^{-1})	Gross margin (Tk. pond^{-1})	BCR
3	35.5	6300	12425	6125	1.97

Table 11.54.2.3 Utilization pattern of harvested Shing fish at FSRD site Ajoddhapur, Rangpur during 2018-2019.

No. of pond	Total production (kg pond^{-1})	Consumption (kg)	Distribution (kg)	Selling (kg)
3	35.5	9.5	3	23

11.55. Maximization of farmers' income through Shing, Tengra and monosex Tilapia culture

There were two ponds selected for each of Shing and Tengra fish. The average size of the ponds was around 10 decimals with average depth of 1.2 meter. There were three ponds selected for monosex Tilapia. The sizes of the ponds were avg. 9 decimal sized with avg. 1.57 m depth. The results revealed that the average survival rate of Shing and Tengra was around 85% whereas the avg. survival rate of monosex Tilapia was 91% (Table 11.55.1). Production and economic analysis are shown in Table 11.55.2. The production and gross margin of fish varied from pond to pond due to its size. Total production of Shing, Tengra and Monosex Tilapia were recorded 45, 36 and 68 kg pond^{-1} and gross margin was recorded Tk. 9050, Tk. 4700 and Tk. 5808 pond^{-1}, respectively. Consumption, distribution, selling, total production, net income and BCR increased due to intervention of new technology (Table 11.55.3 and Table 11.55.4).

Table 11.55.1. Performance of Shing, Tengra and monosex Tilapia fish culture at FSRD site Ganggarampur, Pabna during 2018-2019

Fish	Area and depth of pond (decandm)	Amount and number of fingerlings	Avg. weight of fingerlings (gm)	Final average weight of fish (g)	Total amount and number of fish	Survival rate (%)
Shing	15 Dec. 1.2 m	14 kg and 1400	10	53	60 kg and 1120	80
	6 Dec. 1.2 m	6 kg and 600		55	30.8 kg and 560	93
Tengra	10 Dec. 1.2 m	5 kg and 1000	5	42	34 kg and 820	82
	10 Dec. 1.2 m	5 kg and 1000		44	38 kg and 865	86
Tilapia	15 Dec. 2 m	16 kg and 320	50	385	116 kg and 302	94
	8 Dec. 1.5 m	8 kg and 160		390	56 kg and 145	90
	5 Dec. 1.2 m	5 kg and 100		365	33 kg and 90	90

Table 11.55.2. Production and economics of Shing, Tengra and Tilapia culture at FSRD site Ganggarampur, Pabna during 2018-2019

Fish	Total production (kg pond^{-1})	Total cost (Tk.pond^{-1})	Gross return (Tk.pond^{-1})	Gross margin (Tk.pond^{-1})	BCR
Shing	45	2200	11250	9050	5.12
Tengra	36	2500	7200	4700	2.88
Tilapia	68	2392	8200	5808	3.42

Prize (Tk.kg^{-1}): Shing= 250, Tengra= 200

Table 11.55.3. Utilization pattern of harvested fish at FSRD site Ganggarampur, Pabna

SL No.	Consumption (kg)	Distribution (kg)	Selling (kg)
1. Tengra	5	2	29
2. Shing	6	2	37
3. Tilapia	20	8	40

Table 11.55.4. Fish production, utilization pattern and income before and after intervention at FSRD site Ganggarampur, Pabna during 2018 to 2021

Description	Before intervention	After intervention				
		February 2018 to December 2019		Feb 2019 to Jan 2020	Feb 2020 to January 2021	Average
Consumption (Kg)	40	Tengra	5	72	123	75
		Shing	6			
		Tilapia	20			
Distribution (Kg)	10	Tengra	2	7	12	11
		Shing	2			
		Tilapia	8			
Selling (Kg)	65	Tengra	29	63	80	115
		Shing	37			
		Tilapia	40			
Total production (Kg)	115	Tengra	36	142	215	201
		Shing	45			
		Tilapia	68			
Gross return (Tk.)	13225	18450		18460	32250	23053
Total cost (Tk.)	6850	7700		10200	15900	11267
Grosse margin (Tk.)	6375	13750		8260	16350	11786
BCR	1.93	2.4		1.81	2.03	2.05

11.56. Maximization of farmers' income through carp polyculture technique in seasonal and perennial ponds at different FSRD sites during 2018 -2021.

FSRD site: Ajoddhapur. Rangpur (BARI)

Mixed carp polyculture was conducted at 8 ponds during 2018-19 and 12 ponds during 2019-20 and 2020-2021 of the 12 cooperator farmers' pond. Ponds area, fingerlings amount and weight, final total amount and number of fish, survival rate etc. has been presented in Table 11.56.1.1. The ponds were avg. 13 decimal sized with avg. 3.2 m depth. The results revealed that, in polyculture of carp fishes, the survival rate was 80-93%. Production, cost and return analysis are shown in Table 11.56.1.2. The average produciton of fish after intervention was obtained 99 kg per pond with the gross margin Tk. 10208 per pond. The result of the study consistent with findings of (Uddin *et al.,* 1994).

Picture 11.102. Mixed carp polyculture at FSRD site: Ajoddhapur, Rangpur

The produced fishes were consumed by the farm family, distributed to relatives and sold in local market (Table 11.56.1.2.) It was observed that, farmers sold most of the fish 63%, consumed about 33% and distributed about 4% among their neighbors, relatives and well-wishers of the produced fish. The farmers were benefitted by carp polyculture system and they showed further interest for farming of carp polyculture.

Table 11.56.1.1. Performance of carp polyculture fish farming at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

SL No.	Area and depth of pond (decandm)	Amount and number of fingerlings	Avg. weight of fingerlings (gm)	Final average weight of fish (g)	Total amount and number of fish	Survival rate (%)
Year I	14 dec. and 3.6m	6-10 kg	30	480	98 kg and 204#	85
Year II	13 dec. and 3m	8-12 kg	35	471	105 kg and 223#	93
Year III	13 dec. and 3m	7-11 kg	28	495	95 kg and 192#	80
Average	13 dec. and 3.2m	07-11 kg	31	481	99 kg and 206#	86

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.56.1.2. Fish production, utilization pattern and income before and after intervention at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

Description	Before intervention (kg ha^{-1})	After intervention (kg ha^{-1})			
		Year I	**Year II**	**Year III**	**Average**
Consumption	10	24	35	40	*33*
Distribution	1	3	5	5	*4*
Selling	24	71	65	50	*62*
Total production	35	98	105	95	*99*
Gross return (Tk.)	5250	14700	15750	16625	15692
Total variable cost (Tk.)	1800	5400	5550	5500	5483
Gross margin (Tk.)	3450	9300	10200	11125	10208

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna (BARI)

Five ponds were selected for carp polyculture during 2019-20 and 2020. The ponds were avg. 10 decimal with avg. 2.0 m depth. The results revealed that in polyculture of carp fishes the av. survival rate was 91% (Table 11.56.2.1).

Picture 11.103. Mixed carp polyculture at FSRD site: Ganggarampur, Pabna

Production, utilization pattern, cost and return analysis are shown in (Table 11.56.2.2). The production of fish was obtained 142 kg and 215 kg per pond during 2019-20 and 2020-2021 with the gross margin of Tk. 8260 and Tk. 16350 per pond, respectively. Among the total production farmers consumed, distributed to relatives and sold their products in local market. It was observed that, farmers consumed average about 37%, sold about 58% and distributed about 5% to their neighbor's, relatives and well-wishers of the produced fish. The marginal farmers were benefitted by carp polyculture system and they showed further interest for farming of carp polyculture.

Table 11.56.2.1. Performance of carp polyculture fish farming at FSRD site Ganggarampur, Pabna during 2019 to 2021

Year	Area and depth of pond (dec. and m.)	Amount and number of fingerlings	Avg. weight of fingerlings (g)	Final average weight of fish (g)	Total amount and number of fish	Survival rate (%)
Year II	9 dec. and 2m	37 kg #250	148	747	142 kg #190	92
Year III	10 dec. and 2m	55kg #272	202	1113	215 kg #193	90

* Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.56.2.2. Fish production, utilization pattern and cost and return analysis at FSRD site Ganggarampur, Pabna during 2019 to 2021

Description	Year II	Year III
Consumption (kg)	72	123
Distribution (kg)	7	12
Sell (kg)	63	580
Total production (kg)	142	215
Gross return (Tk.)	18460	32250
Total variable cost (Tk.)	10200	15900
Gross margin (Tk.)	8260	16350

* Yearr II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sholakundu, Faridpur (BARI)

There were four ponds selected for carp polyculture production in perennial ponds. The ponds were average 10 decimal sized with average depth of water was 2.25 m. The average initial weight of fingerling (30.80 g), final average weight (570 g), total amount and number of fingerling (141 kg and 248) and survival rate (75 %) are shown in Table 11.56.3.1. Average body weight was increased 1745% over initial body weight (Table 11.56.3.2). The results revealed that average production of fish after intervention was obtained 141 kg per pond which was 59% higher than before intervention with an average gross margin of Tk. 16828 per pond which was 77% higher over before intervention. Among the production they consumed, distributed to relatives and sell their products in local market. It was observed that, farmers sold most of the fish (85%), consumed about 13% and distributed about 2% through their neighbors, relatives and well-wishers of the produced fish (Table 11.56.3.3). The farmers were benefitted by carp polyculture system and they showed their interest in farming of carp polyculture.

Picture 11.104. Mixed carp polyculture at FSRD site: Sholakundu, Faridpur

Table 11.56.3.1. Performance of carp polyculture fish farming at FSRD site Sholakundu, Faridpur during 2018 to 2021

Year	Area and depth of pond (dec. and m)	Amount and number of fingerlings	Avg. weight of fingerlings (g)	Final average weight of fish (g)	Total amount and number of fish	Survival rate (%)
Year I	10 dec and 2.25 m	8.48 kg and 353 nos.	24.00	445	111 kg and 251 no.	71
Year II	10 dec and 2.25 m	10.50 kg and 318 nos.	33.00	617	148 kg and 243 no.	76
Year III	10 dec and 2.25 m	11.50 kg and 320 nos.	35.50	648	164 kg and 250 no.	78
Average	10 dec and 2.25 m	10.16 kg and 330 nos.	30.80	570	141 kg and 248 no.	75

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.56.3.2. Average performance of carp polyculture fish farming at FSRD site Sholakundu, Faridpur during 2018 to 2021

Species	Initial size (cm)	Initial wt (g)	Size after 60 days (cm)	Weight after 60 days (g)	Size after 180 days (cm)	Weight after 180 days (g)	Body wt. increase % over initial	Survival rate (%)
Silver carp	14	34	20	165	28	640	1782	
Catla	12	28	18	140	24	480	1614	
Ruhu	13	30	19	158	28	560	1766	75

Breed	Initial size (cm)	Initial wt (g)	Size after 60 days (cm)	Weight after 60 days (g)	Size after 180 days (cm)	Weight after 180 days (g)	Body wt. increase % over initial	Survival rate (%)
Mrigel	14	36	20	195	29	690	1816	
Rajputi	10	26	14	136	20	480	1746	
Average	12.60	30.80	18.20	158.80	25.80	570	1745	75

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.56.3.3. Fish production, utilization pattern and income before and after Intervention at FSRD site Sholakundu, Faridpur during 2018 to 2021

Description	Before intervention (kg ha^{-1})	After intervention (kg ha^{-1})			
		Year I	Year II	Year III	Average
Consumption (kg)	275	415	462	491	456
Distribution (kg)	42	63	72	80	72
Selling (kg)	1908	2297	3166	3529	2997
Total production (kg)	2225	2775	3700	4100	3525
Gross return (Tk.)	311500	402375	555000	631400	529592
Total cost (Tk.)	73917	100960	108930	118310	109400
Gross margin (Tk.)	237583	301415	446070	513090	420192

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

There were four ponds selected for carp polyculture production in seasonal ponds. The ponds were average 22 decimal sized with average depth of water was 1.52 m. The average initial weight of fingerlings (6.76 g), final average weight (745 g), total amount and number of fingerling (793 kg and 1071) and survival rate (77 %) are shown in Table 11.56.4.1. The results revealed that average produciton of fish after intervention was obtained 190 kg per pond which was 52% higher than before intervention with an average gross margin of Tk. 12809 pond^{-1}. Among the average production they consumed, distributed to relatives and sell their products in local market. It was observed that, farmers sold most of the fish (48%), consumed about 40% and distributed about 12% through their neighbours, relatives and well-wishers of the produced fish (Table 11.56.4.2). The farmers were benefitted by carp polyculture system and they showed their interest in farming of carp polyculture.

Picture 11.105. Mixed carp polyculture at FSRD site: Atia, Tangail

Table 11.56.4.1. Performance of carp polyculture fish farming at FSRD site, Atia, Tangail during 2018 to 2021

Year	Area and depth of pond (dec. and m)	Amount and number of fingerlings	Avg. weight of fingerlings (g)	Final average weight of fish (g)	Total amount and number of fish	Survival rate (%)
Year I	22 dec, and 1.5 m	9.0 kg and 1420	6.35	670	750 kg and 1120	79
Year II	22 dec, and 1.5 m	9.2 kg and 1370	6.71	824	840 kg and 1020	74
Year III	22 dec, and 1.56 m	10 kg and1390	7.23	742	790 kg and1073	77
Average	22 dec, and 1.52 m	9.4 kg and 1393	6.76	745	793kg and 1071	77

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.56.4.2. Fish production, utilization pattern and income before and after intervention at FSRD site, Atia, Tangail during 2018 to 2021

Description	Before intervention (kg ha^{-1})	After intervention (kg ha^{-1})		
		Year I	Year II	Year III
Consumption (kg)	35	70	90	66
Distribution (kg)	12	20	28	17
Sell (kg)	78	98	92	90
Total production (kg)	1403	2111	2358	1942
Gross return (Tk.)	154375	232210	259380	213620
Total variable cost (Tk.)	80210	84290	88210	88960
Gross margin (Tk.)	74165	147920	171170	112345
BCR	1.92	2.75	2.94	2.26

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur (BARI)

The program of carp polyculture in seasonal ponds was undertaken at the FSRD Sites. Fingerlings were given among the four selected farmers of two villages under this program.

Average size of the ponds was 16.75 decimal with 1.5 m depth and average survival rate was 86%. Average production and number of fish were 291 kg and 358 no. pond^{-1}, respectively, (Table 11.56.5.1). Total production, consumed, distribution, selling and economic analysis are shown in Table 11.56.5.2 It was observed that total production was 4114 kg ha^{-1} with the gross margin of Tk. 264491 ha^{-1}. The farmers were benefitted by carp polyculture system and they showed interest for farming of carp polyculture.

Picture 11.106. Mixed carp polyculture at FSRD site: Tarakandi, Sherpur

Table 11.56.5.1. Performance of carp polyculture fish farming at FSRD site, Tarakandi, Sherpur during 2018 to 2021

SL No.	Area and depth of pond (dec. and m)	Amount and number of fingerlings	Avg. weight of fingerlings (g)	Final average weight of fish (g)	Total amount and number of fish	Survival rate (%)
Year I	16.75 dec. and 1.5 m	20-25 kg	86	950	291 kg and 310#	95
Year II	16.75 dec. and 1.5 m	18-20 kg	79	890	296 kg and 305#	96
Year III	16.75 dec. and 1.5 m	22-26 kg	91	532	288 kg and 460#	90
Average	16.75 dec. and 1.5 m	-	*85*	*615*	*291 kg and 358#*	*86*

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.56.5.2. Fish production, utilization pattern and income before and after Intervention at FSRD site Tarakandi, Sherpur during 2018 to 2021

Description	Before Intervention (kg ha^{-1})	After Intervention (kg ha^{-1})			
		Year I	Year II	Year III	Average
Consumption (Kg)	630	738	720	700	719
Distribution (Kg)	95	160	150	105	138
Sell (Kg)	2710	3420	3250	3100	3257
Total production (Kg ha^{-1})	3435	4318	4120	3905	4114
Gross return (Tk. ha^{-1})	412200	680026	556166	507650	581281

Description	Before Intervention (kg ha^{-1})	After Intervention (kg ha^{-1})			
		Year I	Year II	Year III	Average
Total variable cost (Tk. ha^{-1})	250000	370370	300000	280000	316790
Gross margin (Tk. ha^{-1})	162200	309656	256166	227650	264491

Average pond size = 16 .75 Dec.l. Price of fish=130 Tk.kg^{-1}

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sreepur, Gazipur (BRRI)

Irrespective of fish species, initial average size and weight was 5.0 cm and 29.62 g respectively. The highest gained weight was found in Mrigel (765 g) followed by silver carp, rohu and the lowest was found in shorputi (414g). Average survival rate of fish species was 86.25% (Table 11.56.6.1).

Table 11.56.6.1. Performance of carp polyculture fish farming at FSRD site Sreepur, Gazipur during 2018 to 2021

Breed	Initial size (cm)	Initial wt. (g)	Size after 60 days (cm)	Wt. after 60 days (g)	Size after 180 days(cm)	Wt. after 180 days (g)	Body wt. increase % over initial	Survival rate (%)
Ruhi	5.17	41.25	18.12	196.20	33.27	581.66	1310	82
Silver carp	4.63	24.51	16.43	185.34	34.39	655.14	2573	90
Mrigel	5.06	15.44	17.50	178.65	32.21	764.60	4852	85
Shorputi	5.14	37.29	17.88	180.84	30.56	451.51	1111	88
Average	5.00	29.62	17.48	185.26	32.61	613.23	2462	86.25

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Maximum fish production of the selected farmer was found during 3rd year (2980 kg ha^{-1}) followed by 2nd year (2526 kg ha^{-1}) and the lowest in the 1st year (1350 kg ha^{-1}). The highest gross margin was obtained during 3rd year Tk. 272522 ha^{-1} and the lowest gross margin during 1st year Tk. 122000 ha^{-1}. Consumption, distribution and sold were increased in each year (Table 11.56.6.2).

Table 11.56.6.2. Fish production, utilization pattern and income before and after Intervention at FSRD site Sreepur, Gazipur during 2018 to 2021

Description	Before intervention (kg ha^{-1})	After intervention (kg ha^{-1})		
	2017-18	Year I	Year I	Year I
Consumption (kg)	38	68	75	82
Distribution (kg)	0	5	4	13
Selling (kg)	375	1278	2447	2885
Total production (kg)	413	1350	2526	2980
Gross return (Tk. ha^{-1})	61950	202500	378825	446910
Total cost (Tk. ha^{-1})	37500	80500	155550	174388
Gross margin (Tk. ha^{-1})	24450	122000	223275	272522
BCR	1.65	2.52	2.44	2.56

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

11.57. Semi-aquatic production system of vegetables, fish and fruit in mini pond

FSRD Site: Tengra, Sreepur, Gazipur (BRRI)

Yield of stolon, aroid and vegetables are presented in Table 11.57.1. The highest vegetables yield in dyke was 239 and 281 kg during 2019 and 2020, respectively. The highest yield of aroids was 150 and 1600 kg during 2019 and 2020, respectively (Table 11.57.1). The Maximum yield of stolon was 72 kg and 855 kg, respectively in the two successive years. Maximum gross margin came from the pond of Borhan Uddin Tk. 16660 and Tk. 60350, respectively during 2019 and 2020 and the lowest gross margin was found from the pond of Nurul Haque Tk. 3660 and Tk. 4550, respectively during 2019 and 2020.

Table 11.57.1. Performance of semi-aquatic production system at FSRD site Tengra, Sreepur, Gazipur, 2019-2020

Year	Name of farmer	Area (m^2)	Veg. on dyke	Yield (kg)			Gross return (Tk.)	TVC (Tk.)	Gross margin (Tk.)	BCR
				Aroid		Fish				
				Stem	Stolon					
2019	Borhan Uddin	526	239	150	72	124	22860	6800	16660	3.37
	Abdul Karim	378	145	125	58	78	15140	4900	10940	3.09
	Nurul Haque	140	-	96	26	22	4860	1200	3660	1.33
2020	Borhan Uddin	1130	281	1600	855	185	75070	14700	60350	5.11
	Abdul Karim	378	145	300	240	85	23050	4500	18550	5.12
	Nurul Haque	140	-	100	45	40	7300	2800	4500	2.61

Vegetables: 20 Tk./kg, Aroid stem: 20 Tk./kg, Stolon: 20 Tk./kg, Fish: 110 Tk./kg

Picture 11.107. Semi-aquatic production system of vegetables, fish and fruit at FSRD site: Tengra, Sreepur, Gazipur

11.58. Polyculture of carps using over wintered fingerlings

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

Mean values of six months data of each of the parameter are presented in Table 11.58.1. The water temperature recorded during the study period was more or less similar in two ponds. The mean values of water temperature were 29.21±2.32 and 29.33±2.20 in P-1 and P-2, respectively. Water transparency values of two ponds showed variations on different sampling dates. The mean transparency values were 28.14±3.40 and 24.22±3.10 cm in P-1 and P-2, respectively. The dissolved oxygen values were found to be suitable in the ponds. The mean values of P-1 and P-2 were 5.62±1.50 and 5.50±0.88 mg/l, respectively. During the study period, the pH values of pond water were found to be alkaline. The mean values of pH were 7.89±0.88 and 8.19±0.75 in P-1 and P-2, respectively.

Table 11.58.1. Mean water quality values of the demonstration ponds at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Ramjan Ali (P-1)	Dulal Miah (P-2)
Water Temperature (°C)	29.21±2.32	29.33±2.20
Transparency (cm)	28.14±3.40	24.22±3.10
Dissolved oxygen (mg/L)	5.62±1.50	5.50±0.88
pH	7.89±0.88	8.19±0.75

Details of stocking, harvesting and production of fish species are presented in Table 11.58.2. On the basis of final growth attained by native carp species, Catla showed the best growth performances in the ponds when species wise comparison was made. The harvesting weight of Catla, Rohu, Mrigal and Grass carp in ponds-1 and 2 were 1060 & 980 g, 770 & 790 g, 712 & 750 g and 1250 & 1340 g, respectively.

Picture 11.108. Polyculture of carps at FSRD site: Mokamia, Fulpur, Mymensingh

Table 11.58.2. Stocking density, survival (%) and production of carp in farmer's pond at FSRD site Mokamia, Fulpur, Mymensingh

Farmer's name	Fish species	At stocking		Average harvesting Wt. (g)	Average survival (%)	Production (kg/pond) after 6 months	Total Production (Kg/pond) after 6 months	Average Production (Kg/ha) after 6 months
		Stocking density/acre	Average initial Wt. (g)					
Md. Ramjan Ali (Pond-1)	Catla	1000	55±2.24	1,060	90	240	719	7190
	Rohu	1000	40±3.21	770	86	166		
	Mrigal	1000	48±3.88	712	92	163		
	Grass carp	500	62±3.20	1250	96	150		
Dulal Mia (Pond-2)	Catla	1000	50.00	980	94	368	1144	7150
	Rohu	1000	33.60	790	84	266		
	Mrigal	1000	40.88	750	88	264		
	Grass carp	500	54.23	1340	92	246		

The average survival of fish in the two farmer's pond was almost identical which was found to be varied between the 84-96%. Among the species, Catla showed the best survival among the species. The main factor that may have attributed to the high survival was proper stocking of healthy sized fingerlings, freedom from predation, favorable ecological conditions and proper feeding, etc. Chaudhury *et al.,* (1978) emphasis the importance of these factors in governing the survival. After six months of culture period, the production levels obtained were 719 and 1144 kg in P-1 and P-2, respectively. It is clear that, among the Indian major carps, the contribution of Catla in the ponds to the total production was the highest and that of Mrigal was the lowest. Between the farmers, Mr. Ramjan Ali (P-1) obtained the better production. In usual polyculture system, the growth of Catla has been reported to range from 518 to 532 g in Bangladesh (Hossain *et al.,* 1994). While, a wide variation in the growth of Rohu ranging from 294 to 660 g has been reported by a number of researchers (Rahman *et al.,* 1995; Ali *et al.,* 1997 and Miah *et al.,* 1997). In another study, the growth rate of Mrigal was found to vary from 430 to 741g in one year (Ahmed, 1993), whereas Uddin *et al.,* (1994) reported 447 to 875 g and Mazid *et al.,* (1997) observed 460 to 860g weight gains in 10 months culture period. The growth of Grass carp has been reported to vary from 447 to 1469 g/year (Ahmed, 1993; Miah *et al.,* 1997; and Ali *et al.,* 1997).

Cost and return was performed to estimate the net profits of polyculture. The results of the analysis are shown in Table 11.58.3. While, estimating cost of production, variable costs towards lease value, labour, lime, fingerlings, feed and harvesting costs were taken into consideration. The gross margin of Tk. 48150 and

Tk.1,01,900 as obtained from in P-1 and P-2, respectively. The range of production from the traditional polyculture of carps in Bangladesh was 3,119 to 4,067 kg/ha/yr. (Hossain *et al.,* 1994 and Mazid *et al.,* 1997). In another study, Alam *et al.,* (2002) stated that the fish production of carps with over wintered fingerlings were 2,325 - 2,982 kg/ha/7 months with net benefit of Tk. 87,971-93,755. The findings of the present study have shown that the both fish production and net profit can be increased through polyculture of carps with over wintered fingerlings. However, the lower stocking density, over wintered fingerlings and better management using fertilization and supplementary feed in optimum amounts are three key factors for obtaining higher production with individual large size fish in a shorter culture period.

Table 11.58.3. Cost and return analysis in polyculture with over wintered fingerlings after six months at FSRD site Mokamia, Fulpur, Mymensingh

Item (cost)	P-1 (Ramjan Ali)		P-2 (Dulal Mia)	
	Qty. (Kg)	Amount (Tk.)	Qty. (Kg)	Amount (Tk.)
1. a) Pond Lease value b) Pond Preparation		5000 2500		8000 4000
2. Fingerlings	800 nos.	8000	1280 no.	12800
3. Feed				
a) Rice bran b) Mustard oil cake	1720 450	34400 13500	2450 700	49000 21000
4. fertilizer	-	700	12000	1120
5. Netting		1000		1000
6. Other costs		10000		12000
7. Harvesting cost		1000		2000
8. Total cost		60600		86120
9. Gross return:				
Sell price of fish a) Catla: 160/kg b) Rohu:160/kg c) Mrigal: 150/kg d) Grass carp: 130/-	719 kg	108750	1144	188020
5. Gross margin/pond (Total income- Total cost)		48150		1,01,900
6. Gross margin/acre		192600		254750

Farmers' Reaction: Farmers are very happy to see the individual growth of carps. They are able to understand the advantage of overwinter fingerlings and lower stocking density of carps

11.59. Refinement of Culture technique of Pabda (Ompok pabda) & Gulsha (Mystus cavasius) with Rui (Labeo rohita) in farmers ponds

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

The overall mean values of each water quality parameter in two ponds are presented in Table 11.59.1. Water temperature did not differ much between the ponds. It ranged from 25.20 – 32.3°C and 25.60 – 32.8°C in pond-1 and pond-2 with the mean values of 26.85±0.50 and 26.90±0.65°C, respectively. The variation in

temperature between the ponds were found similar and within the suitable range of growth of fish in tropical ponds (Roy *et al.,* 2002, Begum *et al.,* 2003 and Kohinoor *et al.,* 2004). Water transparency values of two ponds showed variations on different sampling dates. The mean values of water transparency were 28.94±1.70 and 31.30±2.90cm in pond-1 and pond-2, respectively. Boyd (1982) recommended a transparency between 15-40 cm. as appropriate for fish culture. pH varied from 8.21±1.40 and 8.33±1.52 in pond-1 and pond-2, respectively. Ponds water were alkaline throughout the culture period which might be due to regular application of lime in the ponds at monthly interval. The dissolved oxygen contents in pond-1 and pond-2 ranged from 4.8 to 6.2 mg/l and 4.32 to 7.20 mg/l, respectively with the mean values of 5.30±0.33 mg/l and 5.44 ±0.61 mg/l. The fluctuations in dissolved oxygen concentrations in two ponds were within the productive range throughout the culture period (Boyd 1982). The total alkalinity values of the ponds water were found to be at the productive level. The mean values of total alkalinity in pond-1 and pond-2 were 120±7.20 mg/l and 128±5.85 mg/l, respectively. Total alkalinity values found within the suitable range in the present trial.

Table 11.59.1. Mean water quality values of the demonstration ponds at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Layli Begum (P-1)	Jitandra Barman (P-2)
Temperature (°C)	26.85±0.50	26.90±0.35
Transparency (cm)	28.94±1.70	31.30±2.90
pH	8.21±1.40	8.33±1.52
Dissolved oxygen (mg/L)	5.30±0.33	5.44 ±0.61
Total alkalinity	120±7.20	128±5.85

Growth and production performances

Details of stocking, growth and production performances in two ponds are presented in Table 11.59.2. Pabda attained an average harvesting weight of 32±3.85g in Pond-1 and 30±2.90g in Pond-2. In case of Gulsha, the harvesting mean weight was higher than pabda in the ponds. However, it was 36±4.1g and 33±3.5 in Pond-1 and Pond-2, respectively. At harvest, the weights of Rui were 760±52g and 720±70g in Pond-1 and Pond-2, respectively. The survival rate of three species in two ponds was fairly high. The mean survival rate of pond-1 and 2 were 80.66±10.26 and 77±10.96, respectively. There was no significant difference (P>0.05) among the survival rates of fish in two ponds, which ranged between 72 to 92%. The survival rate of pabda and Gulsha were more or less same in the ponds.

Table 11.59.2. Growth and productions of fish under two ponds at FSRD site Mokamia, Fulpur, Mymensingh

Pond	Fish sp.	At stocking		Harvesting wt. (g)	Survival (%)	Species wise production (kg pond^{-1})	Total production (kg pond^{-1})	Total production (kg ha^{-1})
		Initial Wt. (g)	Stocking density /ha					
Pond-1 (Layli Begum)	Pabda	3.2±0.26	200000	32±3.85	78	499	780	7800
	Gulsha	2.40±0.28	75000	36±4.1	72	194		
	Rui	30±2.1	2,500	760±52	92	87		
Pond-2 (Jitandra Barman)	Pabda	3.3±0.33	25,000	30±2.90	74	355	557	6963
	Gulsha	2.52±0.54	75,000	33±3.5	69	136		
	Rui	33.0±2.55	1250	720±70	90	66		

Picture 11.109. Refinement of Culture technique of Pabda & Gulsha with Rohu at FSRD site: Mokamia, Fulpur, Mymensingh

After six months rearing, production were obtained 7800 and 6963 kg/ha from Pond-1 and Pond-2, respectively (Table 11.59.2). The higher production was obtained from Pond-1. The relative contribution of Pabda and Gulsha in total production was 88.85% and 88.15% from pond- 1 and 2, respectively. While in case of Rui, the relative contribution of pond -1 and 2, were 11.15 and 11.85%, respectively.

These production levels were comparable to those obtained in others mono and polyculture systems in South Asian Region. Kohinoor *et. al.* (1997) recorded an average production from semi intensive culture of pabda (Ompok pabda) with rajpunti (Barbodes gonionotus) and common carp (Cyprinus carpio) over six months culture period as 2,932 kg/ha where the contribution of pabda was only 15.27%. But, Kohinoor *et. al.,* (2009) recorded a gross production of 2393 to 2986 kg/ha in six months from a composite culture of Indian major carps with pabda and gulsha, where the contribution of pabda and gulsha were 5.2 to 9.04%, respectively. A study conducted by Kohinoor *et. al.,* (2011) observed the effect of different stocking densities on the production of Pabda and Gulsha in earthen ponds and got a production ranged from 7,175 to 7,687 kg/ha/6 months.

Table 11.59.3. Cost and return analyses of fish production in two ponds at FSRD site Mokamia, Fulpur, Mymensingh

Inputs	**P-1 (25 decimal)**		**P-2 (20 decimal)**	
	Quantity (Kg)	**Cost (Tk.)**	**Quantity (Kg)**	**Cost (Tk.)**
Lease money		5000		4000
Pond preparation		2500		2000
Fingerling	27625	28125	16100	22500
Feed	1450	101500	1050	73500
Fertilizers (Lime)	75	1500	60	1200
Others cost	-	36000	-	30000
Total cost		**174625**		**133200**
Sell price of fish (pabda:Tk..400; Gullsha:Tk. 350 and Rui: Tk..150/kg)	Pabda:499 Gulsha:194 Rui: 87	2,80,550	Pabda:355 Gulsha:136 Rui: 66	1,99,500
Net benefit	**-**	**1,05,925**	**-**	**66,300**

The cost of production and return from culture of Pabda, Gulsha and Rui under two ponds are presented in Table 11.59.3. While estimating cost of production, variables costs towards lease value, labour, lime, feed and other cost were taken into consideration. Due to higher gross production, the net benefit was higher in pond-1. The net benefit of Pond-1 and pond 2 were Tk. 105925 and Tk. 66300, respectively. In case of net benefit of Pabda and Gulsha with tilapia in polyculture management, Kohinoor *et al.,* (2011) found that an amount of Tk. 6,20,200 ha^{-1} could be achieved by applying supplementary feed and fertilization. In the present study, the production as well as net return was very encouraging. The fish farmer would get opportunity to sell the high valued fish Pabda and Gulsha at a higher price in the market and they would also get an opportunity to consume the fish.

11.60. Refinement of Mono sex GIFT Tilapia with Shing in ponds

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Water quality parameter

Results of the water quality parameters such as temperature, transparency, pH, dissolved oxygen, total alkalinity and Ammonia-nitrogen are presented in Table 11.60.1.

Table 11.60.1. Mean water quality values of the demonstration ponds

Parameter	Pond-1 (Bidiuzzaman)	Pond-2 (Sabina)
Temperature (°C)	30.70±1.14	30.64±1.12
Transparency (cm)	26.80±4.47	22.20±6.13
Dissolved oxygen (mg/L)	3.74 ±0.71	4.88±0.40
pH	7.11 to 8.40	7.23 to 8.85
Total Alkalinity (mg/L)	132 ±19.56	147.20 ±29

Temperature is one of the most important physical factors, which influences the physico-chemical and biological environment of a water body. The mean values of water temperature of pond-1 and pond-2 were 30.70±1.14 °C and 30.64±1.12 °C, respectively. The highest temperature was 32.9°C in the month of June in pond-2 and the lowest was 28.0°C in the month of February in both treatments. Water transparency was observed to vary between treatments. The mean values of water transparency were 26.80±4.47 cm and 22.20±6.13 cm in pond-1 and pond-2, respectively. The lowest transparency was 16.7cm in the month of May in pond-2 and the highest was 28.0 in the month of March in pond-1. pH values of pond water were found to be alkaline. The observed range of pH values were 7.11 to 8.40 in pond-1 and 7.23 to 8.85 in pond-2, respectively. Dissolved oxygen is an important chemical factor and its suitable range is critical for success in any aquaculture operation. The level of dissolved oxygen was found to be lower in pond-1. The mean values of dissolved oxygen concentration in pond-1 and 2 were 3.74 ±0.71 and 4.88± 0.40 mg/l, respectively. Total alkalinity was more or less same in both the ponds and the mean values of ponds-1 and 2 were 132 ±19.56 and 147.20 ±29 mg/l, respectively.

Production

The gross production of fish in two ponds was calculated from the growth and survival of each fish species (Table 11.60.2). The survival rates of monosex GIFT in two ponds were fairly high. The average survival of monosex GIFT was higher in pond-1 (89%) while in pond-2, it was 85%. The survival rate of Shing in ponds-1 and 2 were 69 and 72% respectively.

Picture 11.110. Refinement of Mono sex GIFT Tilapia with Shing at FSRD site: Mokamia, Fulpur, Mymenshing

Harvesting weight of monosex GIFT and Shing were 245±4.20 and 47±3.8 g in pond-1, but in case of pond-2, the weights were 220±4.8 and 44±3.7 g. It was observed that harvesting weights of both the species were higher in pond-1 than that of pond-2. The production of monosex GIFT and Shing in pond-1 was 6100 kg/acre, while in pond-2; it was 5310 kg/acre. The contribution of monosex GIFT in total production was 89.34% in pond-1, while in pond-2, it was 88.04%.

In a study, Hussain (2009) has reported to achieve an estimated production of 12000 kg/ha month from monoculture of monosex tilapia with application of feed and fertilizer in five months rearing. While in the present experiment, lower production was noticed. The reason might be due to longer culture period and better management. In a trial conducted by Kohinoor *et al.,* (2017) investigated on evaluation of production performances of Koi (A. testudineus) with Shing (H. fossilis) and GIF Tilapia (O. niloticus) in semi-intensive culture management at three stocking densities by applying supplementary feed. They observed growth was increased in the treatment with lower stocking density and obtained production 17310 to 17995 kg/ha.

A simple cost-benefit analysis was performed to estimate the amount of profit that has been generated from this types of culture. Cost and benefit analysis showed P-1 generated the higher return over a period of four months Tk. 568333 ha^{-1} and lowest net return was found Tk. 566250 ha^{-1} from P-2 (Table 11.60.3). Hussain *et al.,* (1989) analyzed the cost and benefit of Nile tilapia (Oreochromis niloticus) in monoculture condition and got net benefit of Tk. 72,827/ha/6 months, where fish were fed with rice bran and mustard oil cake. In the case of net benefit of Thai koi (Anabas testudineus), Kohinoor *et al.,* (2007) found that Tk. 3, 87,550 ha/4 months could be achieved by applying supplementary feed. In the present study, the net return was higher than the above findings. The production as well as economic return obtained was very encouraging.

Table 11.60.2. Growth and productions of Shing and Mono sex GIFT under two demonstration ponds during February to June 2018 at FSRD site Mokamia, Fulpur, Mymensingh

Pond	Fish sp.	At stocking		Harvesting wt. (g)	Survival (%)	Total Production (kg/pond)	Total Production (kg/acre)
		Initial Wt. (g)	Stocking density/ha				
P-1 (Badrul)	Monosex GIFT	3.50±0.84	62500	245±4.2	89	1635	15250
	Shing	2.20±0.82	50,000	47±3.8	69	195	
P-2 (Sirajul)	Monosex GIFT	3.40±0.77	62500	220±4.8	85	935	13275
	Shing	2.30±0.60	50,000	44±3.7	72	127	

Table11.60.3. Cost and return analyses of fish production in two ponds at FSRD site Mokamia, Fulpur, Mymensingh

Items (cost)	P-1 (Badrul)		P-2 (Sirajul)	
	Qty. (Kg)	Amount (Tk.)	Qty. (Kg)	Amount (Tk.)
1. Pond Lease value		6000		4000
2. Pond Preparation		3000		2000
3. Fingerlings	13500 nos.	13500	9000 nos.	9000
4. Feed	2200	121000	1400	77000
5. fertilizer with lime		800		500
6. Netting	-	2000		1500
7. Other costs	-	6000		4000
8. Harvesting cost	-	1500		1000
9. Total cost	-	153800		99000
10. Gross return:				

Items (cost)	P-1 (Badrul)		P-2 (Sirajul)	
	Qty. (Kg)	Amount (Tk.)	Qty. (Kg)	Amount (Tk.)
Sell price of fish a) Tilapia: 100/kg b) Shing:300/kg	GIFT: 1635 Shing: 195	222000	GIFT: 1062 Shing: 127	144300
11. Gross margin/pond (Total income- Total cost)		**68,200**		**45300**
12. Gross margin/ha		**568333**		**5,66,250**

Farmer's Reaction

- Farmers are very satisfied with the growth and production of GIFT in their ponds
- They are interested to grow the fish for the next time in their ponds

11.61. Culture of Pabda & Gulsha with carp in farmer's pond

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Water quality parameters:

The physico-chemical factors of the two trials ponds water are presented in Table 11.61.1. The water temperature in P-1 and P-2 ranged from: 25.22 - 31.8°C and 26.40 -31.62°C, respectively with the mean values 27.44±0.52 and 27.30 ±0.61°C. The variations in temperature between the ponds were found similar and were within the suitable range for growth of fish in tropical ponds.

Table 11.61.1. Mean values of water quality parameters in demonstration ponds

Water quality parameter	P-1 (Rina Akter)	P-2 (Sahina Begum)
Temperature (°C)	27.44±0.52	27.30 ±0.61
Transparency (cm)	22.30±1.88	25.20±2.80
pH	7.10 to 8.66	7.15 to 8.45
Dissolved oxygen (mg/l)	5.11±0.19	5.22±0.67
Total alkalinity (mg/l)	152±6.20	146±8.54

The mean values of water transparency were 22.30±1.88 and 25.20±2.80 cm in P-1 and P-2, respectively. The values of transparency sometimes varied with sampling dates which could be due to differences in abundance of plankton. The level of pH varied from 7.10 to 8.66 and 7.15 to 8.45 in P-1, and P-2, respectively. The pH in all the pond water was alkaline throughout the culture period which might be due to regular application of lime in all the ponds at monthly interval.

The dissolved oxygen content in the demonstration ponds ranged from 4.6 to 6.6 and 4.70 to 7.6 in P-1 and P-2, respectively, with the mean values of 5.11±0.19 and 5.22±0.67 mg/l. Comparatively suitable level of dissolved oxygen as observed in the demonstration ponds. Total alkalinity ranged from 138 to 160 and 126 to 172 mg/l with mean values of 152±6.20 and 146±8.54 mg/l in P-1 and P-2, respectively. The variations in total alkalinity in the demonstration ponds were within the productive range for aquaculture.

Growth and production performances

Details of stocking, growth and production performances in two ponds are presented in Table 11.61.2. Pabda attained an average harvesting weight of 42±7.20 g in Pond-1 and 38±5.90 g in Pond-2. In case of

Gulsha, the harvesting mean weight was higher than pabda in the ponds. However, it was 34±5.1 g and 30±3.5g in Pond-1 and Pond-2, respectively. At harvest, the weights of Rui were 690±84g and 675±70g in Pond-1 and Pond-2, respectively. At the end of the culture period, the average harvesting weight by Silver carp was 950±95 and 980 ±104g in ponds-1 and 2, respectively.

The survival rate of four species in two ponds was high. The mean survival rate of pond-1 and 2 were 82.50±11.27 and 82.75±11.87, respectively. There was no significant difference (P>0.05) among the survival rates of fish in two ponds, which ranged between 70 to 97%. The survival rate of Pabda and Gulsha were more or less same in the ponds.

After six months rearing, production were obtained 1085 kg and 989 kg from Pond-1 and Pond-2, respectively (Table 11.61.2). The higher production was obtained from Pond-1. The relative contribution of pabda and gulsha in total production was 75.27% and 73.23% from pond- 1 and 2, respectively. While in case of Rui and Silver carp the relative contribution of pond -1 and 2, were 24.73 and 26.77%, respectively.

These production levels were comparable to those obtained in others mono and polyculture systems in South Asian Region. Kohinoor *et.al.,* (1997) recorded an average production from semi intensive culture of Pabda (O. pabda) with Rajpunti (B. gonionotus) and common carp (C. carpio) over six months culture period as 2,932 kg ha^{-1} where the contribution of pabda was only 15.27%. But, Kohinoor *et. al*., (2009) recorded a gross production of 2393 to 2986 kg/ha in six months from a composite culture of Indian major carps with Pabda and Gulsha, where the contribution of Pabda and Gulsha were 5.2 to 9.04%, respectively. A study conducted by Kohinoor *et. al.,* (2011) observed the effect of different stocking densities on the production of Pabda and Gulsha in earthen ponds and got a production ranged from 7,175 to 7,687 kg/ha/6 months.

Picture 11.111. Culture of Pabda & Gulsha with carp at FSRD site: Mokamia, Fulpur, Mymenshing

Table 11.61.2 Stocking density, initial weight and sampling weight of fish in farmers pond at FSRD site Mokamia, Fulpur, Mymensingh

Pond	Fish Sp.	At stocking		Harvest. Wt. (g)	Survival (%)	Species wise prod. (kg/ha)	Total prod. (kg/ha)	Prod. (kg/pond)
		Initial Wt. (g)	Stocking density /ha					
Pond-1 (Rina Akter)	Pabda	3.2	200000	42±7.20	76	6384	10853	1085
	Gulsha	2.40	75000	34±5.1	70	1785		
	Rui	30	2,500	690±84	93	1604		
	S. carp	24	1250	950±95	91	1080		
Pond-2 (Shahin Begum)	Pabda	3.3	200000	38±5.90	74	5624	9892	989
	Gulsha	2.46	75,000	30±3.5	72	1620		
	Rui	33.0	2500	675±70	88	1485		
	S. carp	26	1250	980 ±104	97	1163		

The cost of production and return from culture of Pabda, Gulsha, Rui and Silver Carp under two ponds are presented in Table 11.61.3. While estimating cost of production, variables costs towards lease value, labour, lime, feed and other cost were taken into consideration. Due to higher gross production, the net benefit was higher in pond-1. The net benefit of Pond-1 and pond 2 were Tk. 1,93,536 (Tk. 19,35,360/ha) and Tk. 1,53,713 (Tk. 15,37,130), respectively. Kohinoor *et al.* (1997) analysed the cost and benefit of Pabda with

Rajpunti in polyculture system and got a net benefit of Tk. 93,953/ha/6 months where fish were fed with rice bran and mustard oil cake. In case of net benefit of Pabda and Gulsha with Tilapia in polyculture management, Kohinoor *et al.,* (2011) found that an amount of Tk. 6,20,200 could be achieved by applying supplementary feed and fertilization. In the present study, the production as well as net return was very encouraging. The fish farmer would get opportunity to sell the high valued fish Pabda and Gulsha at a higher price in the market and they would also get an opportunity to consume the fish.

Table 11.61.3. Cost and return analyses of fish production in two ponds at FSRD site Mokamia, Fulpur, Mymenshing

Inputs	P-1 (25 decimal)		P-2 (25 decimal)	
	Quantity (Kg.)	Cost (Tk.)	Quantity (Kg.)	Cost (Tk.)
• Pond preparation	-	5000	-	5000
• Fingerling (nos.)	27875	59375	27875	59375
• Fish Feed	1144	62920	1160	63800
• Chemicals (Lime, Salt)	-	1275	-	1275
• Others cost	-	30000	-	30000
Total cost		**158000**		**159450**
Sell price of fish (Pabda:Tk..380; Gulsha: 400; Rui: Tk..150/kg & Silver carp Tk.100/kg)		**351536**		**313163**
Net benefit/pond	**-**	**193536**	**-**	**153713**
Net benefit/ha	**-**	**1935360**	**-**	**1537130**

11.62. Culture of Monosex GIFT (Oreochromis niloticus) with Shing (Heteropneustes fossilis) and Magur (Clarias batrachus) in farmer's pond

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

The physio-chemical factors of the three demonstration ponds water are presented in Table 11.62.1. The water temperature in P-1 and P-2 ranged from 27.80-31.2°C and 27.80 - 31.6°C, respectively with the mean values 28.42±0.42 and 28.55±0.66°C. The variations in temperature among the ponds were found similar and were within the suitable range for growth of fish in tropical ponds.

Table 11.62.1. Mean values of water quality parameters in demonstration ponds

Water quality parameter	Laily Begum (P-1)	Nilima Dhar (P-3)
Temperature (°C)	28.42±0.42	28.55±0.66
Transparency (cm)	20.20±2.40	23.20±2.50
pH	7.40 - 8.52	7.38 -8.60
Dissolved oxygen (mg/l)	5.45±0.35	5.30±0.67

The mean values of water transparency were 20.20±2.40 and 23.20±2.50 in P-1 and P-2, respectively. The values of transparency sometimes varied with sampling dates which could be due to differences in abundance of plankton. The value of pH varied from 7.40 - 8.52 and 7.38 -8.60 in P-1 and P-2, respectively. The pH in all the pond water was alkaline throughout the culture period which might be due to regular application of lime in all the ponds at monthly interval. The dissolved oxygen content in the demonstration

ponds ranged from 4.30 to 7.6, 4.08 to 6.5 and 4.40 to 6.8 in P-1 and P-2, respectively, with the mean values of 5.45±0.35 and 5.30±0.67 mg/l. Comparatively suitable level of dissolved oxygen as observed in the demonstration ponds.

Growth and production performances

Details of stocking, growth and production performances in different ponds are presented in Table 11.62.2. It was observed that among the species under two ponds, the highest weight was attained by GIFT in P-1. Shing reached an average harvesting weight of 33±3.94 g in P-1 and 38±4.71 g in P-2, respectively. While, the average weight attained by Magur was 122±8.40 in P-1 and 135±5.1g in P-2. It was observed that highest harvesting weight of Shing and Magur were found P-2. At harvest, the weights of monosex GIFT were 218 ±8.50 and 205±8.10 g, in P-1 and P-2, respectively. The weight of GIFT in P-1 showed better growth performance between the ponds. Based on the number of fish harvested at the end of the experiment, survival ranged from 74-93%. Among the species, Shing showed the good survival and Magur performed less survival among the species.

Table 11.62.2. Growth and production of fish under two ponds during the period of trial at FSRD site Mokamia, Fulpur, Mymenshing

Pond	Fish sp.	At stocking		Harvesting. wt. (g)	Survival (%)	Production (kg/ha)	Total Production (kg/pond)
		Initial Wt. (g)	Stock. Dens./ha				
P-1 (Laily Begum)	GIFT	4.0± 1.89	62,500	218 ±8.50	91	12398	1344
	Shing	2.20±0.85	40,000	33±3.94	76	1003	
	Magur	5.0 ±1.10	5000	122±8.40	74	451	
P-2 (Lilima)	GIFT	4.0 ±1.84	62,500	205±8.10	93	11915	1091
	Shing	2.20 ±0.87	40,000	38±4.71	79	1201	
	Magur	5.0 ±1.05	5000	135±5.1	77	520	

After six months rearing, the production were obtained 1344 and 1091 kg from P-1and P-2, respectively (Table 11.62.2). The better production was obtained in P-1, where the contribution of Shing and Magur were 10.50%.

Picture 11.112. Culture of Monosex GIFT with Shing and Magur at FSRD site: Mokamia, Fulpur, Mymenshing

A simple analysis of cost and return was performed to estimate the net profits of this type of polyculture. The results of the analysis are shown in Table 11.62.3. While, estimating cost of production, variable costs towards lease value, labour, lime, fingerlings, feed and harvesting costs were taken into consideration. The costs of production of pond-1 and pond-2 were Tk. 131326 and Tk. 102648, respectively. The net return of Pond-1 and Pond-2 were Tk. 55674 and Tk. 40852, respectively. However, Khan *et al.,* (2003) observed the effect of different stocking densities on production of catfish (H. fossilis) in earthen ponds and got the production range 2080 to 3364 kg ha^{-1}. A study conducted by Kohinoor *et al.,* (2012) obtained production of 7549 to 9031 kg ha^{-1} in six months from H. fossilis in monoculture management. While in the present experiment, higher production as well as higher net benefit was found. The reason might be due to that in the present experiment, Shing (H. fossilis) were cultured with other species which contributed to increase the total production as well as net benefit.

Table 11.62.3. Cost and return analyses of fish production in one hectare area at FSRD site Mokamia, Fulpur, Mymensingh

Item	P-1 (Lalily)		P-2 (Nilima)	
Cost	Qty. (Kg)	Amount (Tk.)	Qty. (Kg)	Amount (Tk.)
1. Pond Preparation		5000		4000
2. Fingerlings	10750 nos.	22000	8600 nos.	17600
3. Feed	1488	77376	1144	59488
4. Lime & Salt		1950		1560
5. Other costs	-	25000		20000
9. Total cost	-	131326		102648
10. Gross return:				
Sell price of fish a) Tilapia: Tk. 100/kg b) Shing: Tk. 350/kg c) Magur: Tk. 400/kg		187000		143500
11. Net Return (Total income- Total cost)		55674		40852
12. Net return/ha		456740		585650

11.63. Polyculture of Carp with GIFT and Shing

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Water quality parameters:

Mean values of six months data of each of the parameter are presented in Table 11.63.1. The water temperature recorded during the study period was more or less similar in different ponds under three treatments. Temperature varied from 26.20 to 31.70 with mean values of 29.30±1.72 and 29.34±1.49°C in pond-1 and 2, respectively. Water transparency values of different ponds under the treatments showed variations on different sampling dates. The transparency values ranged from 24 to 38 and from 28 to 44 cm in Ponds-1 and 2, respectively. The mean values of transparency were found to be 28.50±3.20 and 34.40±3.50 cm in ponds-1 and 2, respectively.

Table 11.63.1 Water quality parameters of the ponds in different treatments at FSRD site Mokamia, Fulpur, Mymensingh

Parameter	Treatment-1	Treatment-2
Temperature (°C)	29.30±1.72	29.34±1.49
Transparency (cm)	28.50±3.20	34.40±3.50
Dissolved oxygen (mg/l)	4.54±1.68	4.30±1.55
pH	7.43-7.92	7.60-8.21
Total Alkalinity (mg/l)	154±18.50	148±22.28

The dissolved oxygen values were found to be relatively low in all treatments. The values of dissolved oxygen were found to range from 3.60 to 6.50 mg/l in pond-1 and 3.44 to 6.20 mg/l in Pond-2. The mean values of Ponds-1 and 2 were 4.54±1.68 and 4.30±1.55 mg/l, respectively. During the study period, the pH values of pond water under different treatments were found to be alkaline. The levels of pH varied from 7.43-7.92 and from 7.60-8.21 in Ponds-1 and 2, respectively. The total alkalinity values of the pond water were found to be productive level. The values of total alkalinity as recorded from water of ponds-1 and 2 were found to vary from 130 to 165 and 124 to 176 mg/l, respectively. The mean values of total alkalinity

in Pond-1 and Pond-2 were found to be 154±18.50 and 148±22.28 mg/l, respectively.

Growth and production performances:

Details of stocking, growth and production performances in different treatments are presented in Table 11.63.2. It was observed that among the carp species, the highest weight was attained by Catla in Pond-2. Catla reached an average harvesting weight of 750±85.20 in pond-1 and 780±95.30 g in pond-2, respectively.

The average weight attained by Rohu was 520±66.70 and 506±69.82g in ponds-1 and 2, respectively at the end of the experimental period. At harvest, the weights of Mrigal were 560±59.80 and 572±61.40 g, in ponds-1 and 2, respectively.

The average final weights of GIFT tilapia were 320±16.20 and 305±12.44 g, in pond-1 and pond-2, respectively. The poor harvesting weight was observed in pond-2 except Catla whereas, comparatively higher harvesting mean weight was observed in pond-1. In case of Shing, the harvesting mean weight was lower in two ponds. However, it was 56±8.92 and 49±7.40 g in ponds-1 and 2, respectively. After six months rearing, the total fish productions were obtained 911 and 587 kg/pond in ponds-1 and 2, respectively (Table 11.63.2). The contribution of GIFT and Shing in total production was 44.95% in pond-1, while in pond-2 was 44.25%.

Picture 11.113. Polyculture of Carp with GIFT and Shing at FSRD site: Mokamia, Fulpur, Mymenshing

Table 11.63.2. Growth and production of fish under two ponds during May to November 2019 at FSRD site Mokamia, Fulpur, Mymensingh

Farmer's name	Fish species	At stocking		Avg. Harvesting Wt. (g)	Avg. Sur. (%)	Prod. (kg/pond)	Total Prod. (kg/ha)	Prod. (kg/pond)
		Density/ha	Avg. Wt. (g)					
Sirajul (P-1)	Catla	2500	55	750±85.20	91	1706	7594	911
	Rohu	2500	40	520±66.70	88	1144		
	Mrigal	2500	48	560±59.80	92	1288		
	GIFT	5000	3	320±16.20	83	1286		
	Shing	50000	2	56±8.92	76	2128		
Kudrat (P-2)	Catla	2500	50	780±95.30	88	1716	7338	587
	Rohu	2500	42	506±69.82	86	1088		
	Mrigal	2500	40	572±61.40	90	1287		
	GIFT	5000	3	305±12.44	86	1311		
	Shing	50000	2	49±7.40	79	1936		

Cost and benefit:

A simple cost-benefit analysis was performed to estimate the amount of profit that has been generated from this type of aquaculture management. The results of the analysis are shown in Table 11.63.3. The costs of production were Tk. 85940 and Tk. 59230 in ponds-1 and 2, respectively. The higher net return of Tk. 94060

was obtained from pond-1. Hussain *et al.,* (1989) analyzed the cost and benefit of Nile tilapia (Oreochromis niloticus) in monoculture condition and got the net benefit of Tk. 72,827/ha/6 months where fish were fed with rice bran and mustard oil cake. In view of above, it may be concluded that the production and economic return of carps with GIFT tilapia and Shing in polyculture management was encouraging but culture of endangered species could ensure the availability as well as conservation of this species in inland waters.

Table 11.63.3. Cost and return analyses of fish production in different densities in one hectare area at FSRD site Mokamia, Fulpur, Mymenshing

Item	P-1 (Sirajul): 30 decimal		P-2 (Kudrat):20 deimal	
Cost	Qty. (Kg)	Amount (Tk.)	Qty. (Kg)	Amount (Tk.)
1. Pond Preparation		6000		4000
2. Fingerlings	7500 nos.	8100	1280 nos.	5400
3. Feed				
Sinking Feed	1250	50000	840	33,600
4. fertilizer	-	1840		1230
5. Other costs	-	20,000	-	15,000
8. Total cost	-	85940	-	59230
9. Gross return:				
Sell price of fish a) Catla: Tk. 150/kg b) Rohu:Tk. 150/kg c) Mrigal: Tk. 140/kg d) GIFT Tilapia: Tk. 110/kg e) Shing: Tk. 350/kg		180000		113820
Net return/pond (Total income- Total cost)		94060		54590
Net return/ha		783833		682375

11.64. Polyculture of carps with Magur and Pabda using overwintered fingerlings

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Details of stocking, growth and production performances in two ponds are presented in Table 11.64.1. It was observed that among the endemic carp species under two ponds, the higher weight was attained by Catla in Pond-1. Catla reached an average harvesting weight of 760±74 g in Pond-1 and 742±68 g in Pond-2. The average weight attained by Rui was 514±38 and 550±48g in Pond-1 and Pond-2, respectively. At harvest, the weights of Mrigal were 502±64 and 524±29 g in Pond-1 and Pond-2, respectively. The average final weights of pabda were 38±4.95 and 35±4.80 in Pond-1 and Pond-2, respectively. Incase of Magur, the harvesting mean weight was higher than pabda in all the ponds. However, it was 148±7.2 and 135±9.67g in Pond-1 and Pond-2, respectively.

Table 11.64.1. Growth and production of fish under two ponds during June to December 2020 at FSRD site Mokamia, Fulpur, Mymensingh

Treat-ment	Fish sp.	At stocking		Harvesting wt. (g)	Survival (%)	Species-wise production (kg/pond)	Total production (kg/ha)
		Initial Wt. (g)	Stocking density/ha				
Pond-1	Catla	20.6±0.94	2,500	760±74	87	165	13767
	Rohu	17.20±1.31	2,500	514±38	89	114	
	Mrigal	19.7±1.00	2,500	502±64	82	103	
	Pabda	4.6±0.77	250000	38±4.95	77	732	
	Magur	4.0±0.80	25,000	148±7.2	71	263	
Pond-2	Catla	22.05±1.20	2,500	742±68	83	154	12784
	Rohu	19.88±1.21	2,500	550±48	85	167	
	Mrigal	16.0±1.40	2,500	524±29g	80	105	
	Pabda	4.80±0.70	250000	35±4.80	72	630	
	Magur	4.20±0.66	25,000	135±9.67	66	223	

The survival rate of various species in two ponds was fairly high accepting Magur. The main factor that may have attributed to the high survival was proper stocking of healthy seed stocked, freedom from predation favourable ecological conditions and proper feeding etc. The mean survival rate of pond-1 and 2 were 81.20± 7.30 and 77.20±7.98, respectively. The survival rate of pabda and Magur was more or less same in between the ponds. After six months rearing, the production were obtained 1377 and 1278 kg from Pond-1 and Pond-2, respectively (Table 11.64.1).

11.65. Culture of Koi with tilapia and silver carp in farmers pond

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Details of stocking, growth and production performances in two ponds are presented in Table 11.65.1. It was observed that Koi reached an average harvesting weight of 112±8.41 g in Pond-1 and 118±7.90 g in Pond-2. The average weight attained by GIFT tilapia was 315±12.24 and 305±14.2 g in Pond-1 and Pond-2, respectively. While the average final weights of Silver carp were 1140±102 and 1106±94 in Pond-1 and Pond-2, respectively.

Table 11.65.1. Growth and productions of fish under two ponds at FSRD site Mokamia, Fulpur, Mymensingh

Pond	Fish Species	At stocking		Harvesting wt. (g)	Sur. (%)	Species wise prod. (kg/pond)	Total prod. (kg/ pond)	Total prod. (kg/ha)
		Initial Wt. (g)	Stocking density /ha					
Pond-1 Jashim (0.30 acre)	Koi	0.90±0.2	375000	112±8.41	82	2755	3331	27758
	GIFT	2.50 ±0.18	50000	315±12.24	88	416		
	S. carp	70±12	1250	1140±102	94	160		
Pond-2 Hosen Ali (0.15 acre)	Koi	0.88±0.23	375000	118±7.90	87	1540	1812	30200
	GIFT	2.40± 0.27	50000	305±14.2	85	194		
	S. carp	75±10	1250	1106±94	91	78		

The gross production of fish in two ponds was calculated from the growth and survival of each fish species. The survival rate of various species in two ponds was fairly high. The main factor that may have attributed to the high survival was proper stocking of healthy seed stocked, freedom from predation favorable ecological conditions and proper feeding etc. In case of Koi, the survival rate of pond-1 and 2 were in 82% and 87%, respectively. However, overall mean survival rate of pond-1 and 2 was 88±6 and 87±5, respectively. After five months rearing, the production obtained were 3331 and 1812 kg from Pond-1 and Pond-2, respectively. The yield of Koi was 2755 and 1540 kg in pond 1 and 2, respectively. Among the species, individual contribution was comparatively highest in case of Koi (about 82-84%).

Picture 11.114. Culture of Koi with tilapia and silver carp at FSRD site: Mokamia, Fulpur, Mymenshing

11.66. Culture of Shing with Magur in ponds

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

The gross production of fish in two ponds was calculated from the growth and survival of each fish species (Table 11.66.1). The survival rates of Shing and Magur in two ponds were fairly high. The average survival of Shing was higher in pond-2 (79%) while in pond-1, it was 76%. The survival rate of Magur in ponds-1 and 2 were 72 and 68 %, respectively.

The harvesting weight of Shing and Magur were 45±7.8 and 162±18 g in pond-1, but in case of pond-2, the weights were 49±6.95 and 155±21 g. It was observed that harvesting weights of Shing was higher in pond-2 than that of pond-1. The production of Shing and Magur in pond-1 was 2001 kg, while in pond-2, it was 2199 kg. The contribution of Shing in total production was 85.46% in pond-1, while in pond-2, it was 88%.

Picture 11.115. Culture of Shing with Magur at FSRD site: Mokamia, Fulpur, Mymenshing

Table 11.66.1. Growth and productions of Shing and Magur under two demonstration ponds at FSRD site Mokamia, Fulpur, Mymensingh

Pond	Fish sp.	At stocking		Harvesting wt. (g)	Survival (%)	Total Production/pond (kg)	Total Production (kg/ha)
		Initial Wt. (g)	Stocking density/ha				
P-1	Shing	3.12±0.44	5,00,000	45±7.8	76	1710	20016
	Magur	1.42±0.23	25,000	162±18	72	291	
P-2	Shing	3.22±0.38	5,00,000	49±6.95	79	1935	21990
	Magur	1.31±0.17	25,000	155±21	68	264	

E. Off-Farm Activities

Other than agricultural activities, which called off-farm activities is also a good opportunity for increasing farm total income.

11.67. Maximization of farmers' income through Off-farm activities at different FSRD Sites during 2018 to 2021

FSRD site: Ajoddhapur, Rangpur (BARI)

Initially one household started handicrafts making and finally most of the households were practiced handicrafts besides of other off-farm activities. It was found that after intervention the Avg. net return increased 89%, with the avg. net return of Tk. 6226 (Table 11.67.1.1). Therefore, if all households could introduce some off-farm activities, it would be helpful to increase total farm income.


Picture 11.116. Off-farm activities at FSRD site Ajoddhapur, Rangpur

Table 11.67.1.1. Cost and return of off-farm activities at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

Activities	Before intervention (Tk.)	After intervention (Tk.)			
		Year I	Year II	Year III	Average
Khata making, Handicrafts etc.	Kantha making, Irrigation, Cooking	Handicrafts, Sewing, Kantha making, Irrigation, Cooking	Handicrafts, Sewing, Kantha making, Irrigation, Cooking	Handicrafts, Sewing, Kantha making, Irrigation, Cooking	Handicrafts, Sewing, Kantha making, Irrigation, Cooking
Production cost	1833	3583	3455	3333	3457
Sale value (Tk.)	5133	10583	9250	9217	9683
Net return (Tk.)	3300	7000	5795	5883	6226

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Ganggarampur, Pabna (BARI)

Three households were practiced with off-farm activities such as sewing clothes, making of kumara bora, puffed rice, seedling raising in nursery, preparation of Jam/Jelly/Acher, Tailoring, Mudi shop etc. It was found that some off farm activities exhibited good cash income which contributed livelihood of the resource poor farmers to some extent. After intervention net benefit from off- farm activities were recorded Tk. 5765 farm^{-1} (Table 11.67.2.1). So, if all households could introduce some off-farm activities, it would be helpful to increase their total farm income which eventually contributes livelihood improvement of the rural household.

Picture 11.117. Off-farm activities at FSRD site Ganggarampur, Pabna

Table 11.67.2.1. Cost and return of off-farm activities at FSRD site, Ganggarampur, Pabna during 2018 to 2021

Activities	Before intervention (Tk.)			After intervention (Tk.)								
				Year I			Year II			Year III		
	Total income	Cost	Net income	Total income	Cost	Net income	Total income	Cost	Net income	Total income	Cost	Net income
Sewing katha	666	320	346	4000	2000	2000	11000	3500	7500	7650	4500	3150
Puffed rice (Muri vaja)/Kumra bora	483	230	253	2500	1050	1450	2300	1050	1250	1430	820	610
Seedling nursery	200	50	150	800	200	600	1400	652	750	1740	650	1090

Activities	Before intervention (Tk.)			After intervention (Tk.)								
				Year I			Year II			Year III		
	Total income	Cost	Net income	Total income	Cost	Net income	Total income	Cost	Net income	Total income	Cost	Net income
Jam jelly	20	15	5	80	20	60	1620	550	1070	650	290	360
Tailoring	46	20	26	200	60	140	5750	1420	4330	3120	750	2370
Mudi shop	100	50	50	500	200	300	22800	14150	8650	35500	19300	16200
Total	1515	685	830	8080	3530	4550	44870	21322	23550	50090	26310	23780
Average	505	228	277	2693	1176	1517	14956	7107	7850	16697	8770	7927

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sholakundu, Faridpur (BARI)

Four households were practiced with off-farm activities such as vermicompost production and honey production using honey box. It was found that gross margin of Tk. 4600 obtained after intervention of vermicompost the (Table 11.67.3.1) as well as farmers using this product to their homestead gardening. Honey production just started previous rabi season (2019-20) and farmers hoped profit will come from next rabi season. So, if all households could introduce some off-farm activities which would be helpful to increase total farm income.

Picture 11.118. Off-farm activities at FSRD site Sholakundu, Faridpur

Table 11.67.3.1. Cost and return of off-farm activities at FSRD site Sholakundu, Faridpur 2019-2021

Activities	Economy	Before intervention	After intervention			
			Year I	Year II	Year III	Total
Vermicompost production	Production cost	--	--	4100	800	4900
	Sale value (Tk.)	--	--	5300	4200	9500
	Net return (Tk.)	--	--	1200	3400	4600
Honey production	Production cost	--	--	7500	--	7500
	Sale value (Tk.)	--	--	4200	--	4200
	Net return (Tk.)	--	--	--	*	--

*Honey box will be used for next year honey production so; net return cannot be included.

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Atia, Tangail (BARI)

Two households were practiced off-farm activities such as hatching eggs by incubator and vermicompost production. It was found that after intervention the gross margin increased 40 % with the gross margin of Tk. 27902 (Table 11.67.4.1). Therefore, if all households could introduce some off-farm activities which would be helpful to increase total farm income.

Picture 11.119. Off-farm activities at FSRD site Atia, Tangail

Table 11.67.4.1. Cost and return of off-farm activities at FSRD site, Atia, Tangail during 2018 to 2021

Activities	Before intervention	After intervention			
		Year I	Year II	Year III	Average
Hatching eggs and Vermicompost	Hatching eggs 2160 and vermicompost 1340 kg	Hatching eggs 5760 and vermicompost 2340 kg	Hatching eggs 6480 and Vermicompost 2964kg	Hatching eggs 5040 and Vermicompost 2730kg	Hatching eggs 5760 and Vermicompost 2678kg

Activities	Before intervention	After intervention			
		Year I	Year II	Year III	Average
Production cost (Tk.)	23300	37275	36675	30928	34959
Sale value (Tk.)	43200	58800	70464	59320	62861
Net return (Tk.)	19900	21525	33789	28392	27902

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Tarakandi, Sherpur (BARI)

It was found that after intervention the income increased than before intervention. After intervention average net income was Tk. 4500 whereas before intervention only Tk. 2000. So, FSRD site team of Tarakandi, Sherpur could introduce some off-farm activities at their project area, it would be helpful to increase total farm income (Table 11.67.5.1).

Picture 11.120. Off-farm activities at FSRD site Tarakandi, Sherpur

Table 11.67.5.1. Cost and return of off-farm activities at FSRD site Tarakandi, Sherpur during 2018-2021

Activities	Before intervention	After intervention			
		Year I	Year II	Year III	Average
Kantha making, making Coconut strick etc.	Kantha making, making Coconut strick	Kantha making, making Coconut strick	Kantha making, making Coconut strick	Kantha making, making Coconut strick	Kantha making, making Coconut strick
Production cost (Tk.)	11000	12000	9000	9500	10166
Sale value (Tk.)	13000	16000	13000	15000	14666
Net return (Tk.)	2000	4000	4000	5500	4500

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

FSRD Site: Sreepur, Gazipur (BRRI)

The off farm activities done by rural woman during leisure period have been presented in the Table 11.67.6.1 and Table 11.67.6.2. The off farm activities of copperator farmers was dress making and mushroom production. It was observed that after intervention gross return and gross margin were increased over before intervention through two activities. The average gross return were Tk. 32700 and Tk. 4100 and gross margin were Tk. 19400 and 2100 per farm family from dress making and mushroom production after intervention (Table 11.67.6.1 and Table 11.67.6.2). It was observed that total yield of mushroom was 10.25 kg after two months of cultivation per household. From total production each farmer were consumed, distributed and sold 49%, 22% and 29%, respectively (Table 11.67.6.2).

Table 11.67.6.1. Cost and return of off-farm activities at FSRD site Sreepur, Gazipur during 2018-2021

Activities	Before intervention	After intervention
Dress making (no.)	30	218
Production cost (Tk.)	2000	13300
Gross return (Tk.)	4500	32700
Gross margin (Tk.)	2500	19400

* Year I= Feb.2018-Jan.2019, Year II= Feb.2019-Jan.2020 & Year III= Feb.2020- Jan.2021

Table 11.67.6.2. Yield, disposal pattern and cost return of mushroom at farmers household of the FSRD site, Tengra, Sreepur, Gazipur, February 2020- January 2021

Total yield (Kg)	Total yield (kg)			Total Cost (Tk.)	Gross return (Tk.)	Gross margin (Tk.)
	Consumption	Distribution	Sell			
10.25	5	2.25	3	2000	4100	2100

Mushroom per kg@400 Tk.

Picture 11.121. Off-farm activities at FSRD site Tengra, Sreepur, Gazipur

F. Income enhancement

11.68. Sector wise income enhancement at FSRD sites during 2018-2021

FSRD site: Ajoddhapur, Rangpur (BARI)

By integration of year-round vegetables production, HYV seeds, improved cropping patterns and production technologies, de-worming, vaccination program, Carp polyculture, the resources (land, labour, capital, etc.) of the farmers have used optimally and therefore farmer's income have been increased, which may lead to improve livelihood. Before intervention of the project, an average per farm gross margin was Tk. 45433 whereas it was Tk. 133931 after intervention of the project activities (Table 11.68.1). The average increment of gross margin after intervention was 295% compared to before intervention.

Table 11.68.1. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

Component	Cost & return before intervention (Tk.)			Cost & return after intervention (Tk.)				% increase in gross margin after intervention
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Gross Margin increased	
Homestead	7308	1900	5408	27681	5835	21846	16438	304
Field crop	54725	43800	10925	186674	82692	103982	93057	852
Livestock	27850	5500	22350	50035	12917	37118	14768	66
Fisheries	5250	1800	3450	15692	5500	10192	6742	195
Off-farm	5133	1833	3300	9683	3457	6226	2926	89
Total	100266	54833	45433	289765	110401	179364	133931	295

FSRD Site: Ganggarampur, Pabna (BARI)

Integrated farming with holistic approach exhibited remarkable improvement in overall farm productivity and income. By integration of year-round vegetables production, HYV seeds, improved cropping patterns and production technologies, de-worming, vaccination program, carp polyculture, the resources (land, labour, capital, etc.) of the farmers have used optimally and therefore farmer's income have been increased, which may lead to improve livelihood. It was observed that maximum return was recorded from the field crop followed by livestock during three consecutive year's which was around 73% and 60% higher over previous intervention status of field crop and livestock, respectively. However, year-round vegetables and fruits in homestead also exhibited remarkably higher economic return which was 63% higher over previous intervention. Regarding increase percentage of different component over previous status, fisheries sector

demonstrated maximum increase (412%) in return over previous status followed by off-farm activities (46%) (Table 11.68.2).

Table 11.68.2. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Ganggarampur, Pabna during 2018 to 2021

Name of item	Cost & return before intervention (Tk.)			Cost & return after intervention (Tk.)				% increase in gross margin after intervention
	Gross Return	Cost	Gross Margin	Gross Return	Cost	Gross Margin	Gross Margin increased	
Homestead	27247	5982	21265	44665	9933	34732	13467	63
Field crop	139500	70300	69200	235567	115600	119967	50767	73
Livestock	125450	62500	62950	202300	101800	100500	37550	60
Fisheries	4350	2500	1850	19253	9777	9476	7626	412
Off-farm	12500	1250	11250	28475	12056	16419	5169	46
Total	309047	142532	166515	530260	249166	281094	114579	69

FSRD Site: Sholakundu, Faridpur (BARI)

By integration of year-round vegetables production, improved cropping patterns and production technologies, de-worming, vaccination program, carp polyculture, the resources (land, labour, capital) of the farmers have used optimally and therefore farmer's income have been increased, which may lead to improve livelihood. It was observed that maximum return recorded from the crop sector area which was 204% increased after intervention of technologies. The second highest gross margin increased in homestead that was 186% followed by fisheries (77%). The livestock component and off-farm activities contributed a good amount to increase farm income (Table 11.68.3).

Table 11.68.3. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Sholakundu, Faridpur during 2018 to 2021

Component	Cost & return before intervention (Tk.)			Cost & return after intervention (Tk.)				% increase in gross margin after intervention
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Gross Margin increased	
Crop sector	123100	95300	27800	195133	110672	84462	56662	204
Homestead	6268	556	5712	18885	2557	16328	10616	186
Livestock	3605	1365	2240	7043	3191	3852	1612	72
Fisheries	12460	2957	9503	21184	4376	16808	7305	77
Off-farm	0	0	0	3167	1633	1533	1533	-
Total	145433	100178	45255	245412	122429	122983	77728	172

FSRD Site: Atia, Tangail (BARI)

By integration of year-round vegetables production, HYV seeds, improved cropping patterns and production technologies, de-worming, vaccination program, carp polyculture, the resources (land, labour, capital, etc.) of the farmers have used optimally and therefore farmer's income have been increased, which may lead to improve livelihood. It was observed that maximum return recorded from the homestead area which was 246% increased after intervention of technologies. The second highest gross margin increased in livestock component that was 81% followed by field crop sector (57%). The fisheries component and off-farm activities contributed a good amount to increase farm income (Table 11.68.4).

Table 11.68.4. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Atia, Tangail during 2018 to 2021

Component	Cost & return before intervention (Tk.)			Cost & return after intervention (Tk.)				% increase in gross margin after intervention
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Gross Margin increased	
Homestead	2026	573	1453	7154	2122	5032	3579	246
Field crop	53870	35170	18700	65230	35851	29379	10679	57
Livestock	39000	23850	15150	61041	33640	27402	12252	81
Fisheries	16832	7144	9688	21853	7921	13932	4244	44
Off-Farm	43200	23300	19900	62861	34959	27902	8002	40
Total	154928	90037	64891	218139	114493	103647	38756	60

FSRD Site: Tarakandi, Sherpur (BARI)

By integration of year-round vegetables production, HYV seeds, improved cropping patterns and production technologies, de-worming, vaccination program, carp polyculture, the resources (land, labour, capital, etc.) of the farmers have used optimally and therefore farmer's income have been increased, which may lead to improve livelihood. It was observed that maximum return recorded from homestead area which was 646% higher before intervention and field crop increased by 571% after intervention of technologies. The average increment of gross margin after intervention was 247% compared to before intervention (Table 11.68.5).

Table 11.68.5. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Tarakandi, Sherpur during 2018 to 2021

Component	Cost & return before intervention (Tk.)			Cost & return after intervention (Tk.)				% increase in gross margin after intervention
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Gross Margin increased	
Homestead	1004	510	494	8506	4822	3684	3190	646
Field crop	334055	237825	96230	1260256	614770	645486	549256	571
Livestock	11,080	4800	6,280	16820	8083	8737	2457	39
Fisheries	412200	250000	162200	581281	316790	264491	102291	63
Off-farm	7000	5000	2000	14667	10167	4500	2500	125
Total	765339	498135	267204	1881530	954632	926898	659694	247

FSRD site: Sreepur, Gazipur (BRRI)

Before and after intervention, faremers average income from different component of the farming are presented in the Table 11.68.6. It was observed that the highest average gross margin was obtained from crop sector (Tk. 277550 /farmer) followed by fisheries sector (Tk. 119500 /farmer). After intervention it was observed that the whole farm income was increased about 135% per farmer through interventing in different sectors.

Table 11.68.6. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Sreepur, Gazipur during 2018 to 2021

Component	Cost & return before intervention (Tk.)			Cost & return after intervention (Tk.)				% increase in gross margin after intervention
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Gross Margin increased	
Homestead	2360	1000	1360	4950	1750	3200	1840	135
Crop sector	334000	230000	104000	612550	335000	277550	173550	167
Livestock	10500	4600	5900	44000	25000	19000	13100	222
Fisheries	145000	76000	69000	235000	115500	119500	50500	73
Off farm	4500	2500	2000	14000	5500	8500	6500	325
Total	496360	314100	182260	910500	482750	427750	245490	135

FSRD site: Mukamia, Fulpur, Mymensingh (BFRI)

Change among the project farmers through project intervention is presented in the Table 11.68.7. It is observed from the table that highest improvement is occurred in the crop sector in terms of gross margin that is 152% higher before the project activities and lowest improvement in livestock sector. Overall improvement through project activities was 104% over before interventions.

Table 11.68.7. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Mokamia, Mymensingh during 2018 to 2021

Component	Cost & return before intervention (Tk.)			Cost & return after intervention (Tk.)				% increased in Gross margin
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Gross Margin increased	
Homestead	41747	12525	29222	76133	15241	60892	31670	108
Crop sector	62800	30960	31840	145625	65460	80165	48325	152
Livestock	3800	1700	2100	5732	2115	3617	1517	72
Fisheries	350000	220000	130000	800000	550000	250000	120000	92
Total	458347	265185	193162	1027490	632816	394674	201512	104

G. Local Service Provider

11.69. Development of Local Service Provider at different FSRD sites during 2018 to 2021

FSRD site: Ajoddhapur, Rangpur (BARI)

One co-operative farmer is acted as male LSP and one is acted as female LSP at the project area. The male LSP produced different types of vegetables and fruits seedling in his own nursery and also collected seeds and seedlings from other source and supplied to the project farmers and remaining part sold to the neighbour other farmers. The beneficiary farmers are return back some parts of their produce (vegetables/fruits/seeds) to the LSP. The female LSP provided training on handicrafts production and sewing by sewing machine to the other female farmers and also discussed with women regarding nutrition and sanitation. These activities were found a suitable practice for the sustainable farming activities. Table 11.69.1 shows the activities of male LSP and Table 11.69.2 shows the activities of female LSP.

Picture 11.122. Local Service Provider (LSP)

Table 11.69.1. Activities of male Local Service Provider (LSP) at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

Activities/crop	No. of seedling produce		Supply to homestead member (no.)		Sell to other farmer (no.)		Gross return (Tk.)		Total variable cost (Tk.)		Gross margin (Tk.)		
	2019-20	2020	2019-20	2020	2019-20	2020	2019-20	2020	2019-20	2020	2019-20	2020	Av.
Bottle gourd	750	700	12	12	13	13	1500	1400	550	550	950	850	900
Bitter gourd	380	450	12	12	9	9	760	900	300	300	460	600	530
Brinjal	5000	4500	12	12	11	11	5000	4500	600	600	4400	3900	4150
Tomato	6000	5400	12	12	16	16	6000	5400	600	600	5400	4800	5100
Cabbage	3000	3200	12	12	11	11	6000	6400	1600	1600	4400	4800	4600
Cauliflower	2500	3000	12	12	7	7	5000	6000	1500	1500	3500	4500	4000
Chilli	5000	4800	12	12	20	20	5000	4800	800	800	4200	4000	4100
Napier cutting	200	250	12	12	0	0	400	500	50	50	350	450	400
Sugarcane seedling	-	50	-	12	-	4	-	250	-	50	-	200	200
Dragon fruit seedling	-	55	-	12	-	10	-	1100	-	165	-	935	935
Total		22405		120		101	29660	31250	6000	6215	23660	25035	24348

Table 11.69.2. Activities of female Local Service Provider (LSP) at FSRD site Ajoddhapur, Rangpur during 2018 to 2021

Sl no.	Activities	No. of female trainee
1	Training on handicrafts preparation	15
2	Training on Sewing machine	26

H. Integration among different components

11.70. Feasibility study on integration among different household components at different FSRD sites during 2018 to 2021

FSRD site: Ajoddhapur, Rangpur (BARI)

A single enterprise is not enough to income generation of small and marginal farmers or meet up the employment year round other than the integrated farming system research (Behera et al., 2013). Several enterprises of a farmer like home gardening with vegetables and fruits, crops and cropping system, dairying, poultry, fishery, etc. are interrelated. The end product and wastage of one enterprise was used as inputs in another enterprise. Moreover, judicious use of farm resources can reduce production cost and can help to keep clean the environment. In integrated farming, the contribution of one component on other component (s) is important consideration for sustainable farming. Two types of integration were found among the different components of a farm, one is direct integration, and another is indirect integration. The direct integration was conducted through sharing of the product or by product directly with each other and in case of indirect integration, it was happened through sharing money or nutrition or labor with each other. Some examples are given below-

Figure 11.1. Direct and indirect integration based on pond

Figure 11.2. Direct integration between crops and livestock

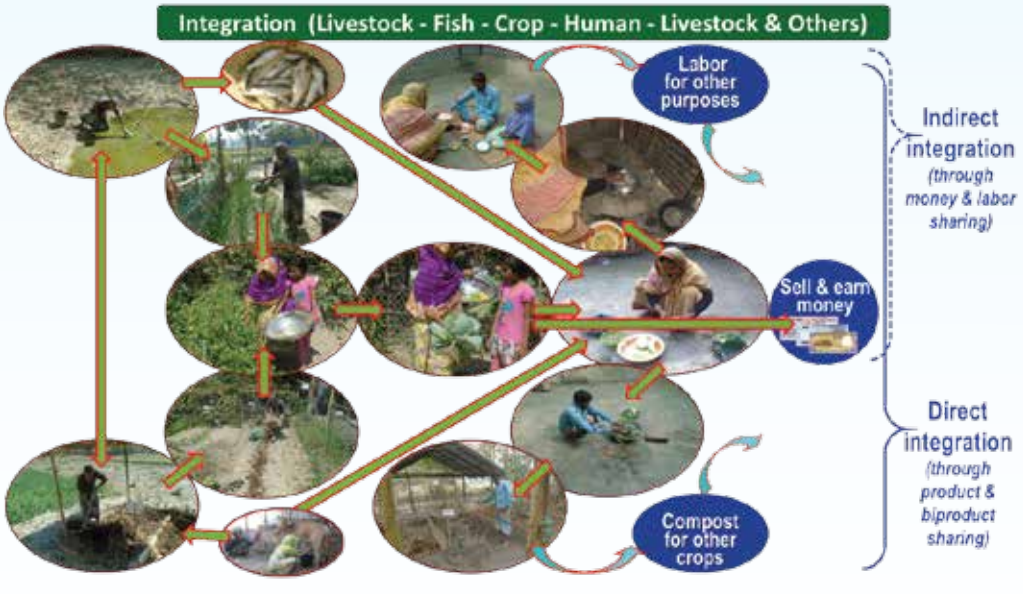


Figure 11.3. Integration among different household components at FSRD site: Ajoddhapur, Rangpur

I. Livelihood improvement (sustainability)

Livelihood improvement is a very complex system and an individual's livelihood involves the capacity to acquire basic necessities in order to satisfy the basic needs. Increasing the capability of sufficient earning, security of nutritional and safe food, medical care, education, assets, acceptable life leading with social status may involve with the livelihood improvement (Table 11.70.1). However, the parameters that were considered for the sustainability of livelihood improvement under different FSRD sites are given below.

Table 11.70.1. Livelihood improvement parameters (sustainability) after intervention of the project activities at different FSRD sites during 2018 to 2020

Sl. No.	Area of consideration	Impact created	Indicator to assess the sustainability
1	Income enhancement	Gross margin increased by 59-385%	-Production of vegetables and fruits in homestead area considering time and space properly -Production was done in integrated way to minimize production cost and maximize yield -Used FRG for balanced fertilization of crops (Cereals, Oilseeds, and Vegetables etc.) -Used of modern varieties -Innovative technologies -Used fallow land under cultivation - Increased production skill due to training
2	Family nutrition	Improved satisfactorily	-Vegetables intake from homestead source increased 163-1528% -Fruit intake from homestead source increased 16-131% -Fish and poultry meat and egg production and intake increased remarkably -Changed in consumption habit towards vegetables and fruit -Reduced no. of attack and frequency of diseases
3	Soil health	Maintenance/ Increased	-Used of organic matter (FYM, vermicompost, green manure) -Decreased the use of insecticides/chemicals due to use of organic matter and IPM technology
4	Resource use pattern	Increased	-Used homestead (100%) -Introduction of homestead vegetables production model for respective site using 8 to 10 production niches.
5	Technical knowledge	Increased sharply	-Young girls and boys are engaged for implementation of new technologies -Training, field days, LSP activities, fortnightly meeting with field staffs and farming group and exchange of views with different type of peoples.
6	Adaptation innovation	Increase of 60-70%	-New crops, varieties are used -Used of recommended fertilizers -Used of different preservation and curative measures of food and seeds - LSP activities
7	Employment	Increased	-Used of unutilized family labor -Women participation in Agricultural activities (Homestead vegetables, livestock, duck and poultry rearing, compost making) the new technology and created employment. - Male and female LSP development
8	Micro-environment	Improved	-Household wastes being used for composting and their used in crops -Used of IPM/bio-pesticides saved environment from pollution. -New plantation and increased vegetables contribute to favorable environment
9	Housing	Improved	New house and repairing of house helps in improve living

Sl. No.	Area of consideration	Impact created	Indicator to assess the sustainability
10	Social status	Improved	-Increased access of better living standard to people -Improved mental strength due to higher income, development of skill on technologies and public conduct.
11	Education	Improved	-Women empowerment especially increased income made them to educate their children for a better future.
12	Women participation	Increased	-Homestead vegetables cultivation -Tree plantation and nursing -Composting -Seed preservation - Homestead mini nursery -Cow, Poultry and Duck rearing -Female LSP development -All these ensured women empowerment

12. Research Highlights

12.1. Homestead Production System

12.1.1. Year Round Vegetables and Fruits Production in Homestead (5 FSRD Sites of BARI)

Title : Year Round Vegetables and Fruits Production in Homestead

Background: Vegetables and fruits are the major dietary nutritional source for the mass people in Bangladesh. Per day per head consumption of vegetables and fruits in Bangladesh are very low. Intensive vegetables and fruits production could provide not only nutritional security but also be useful for employment generation, higher farm income, better export potential and lower dependency on cereal consumption. Farmers in rural areas especially low-income groups are seriously suffering from malnutrition. Scarcity of vegetables and fruits causes the problems of malnutrition such as iron deficiency, anemia, and exophthalmia etc. Nutritional problem can be reduced by regular consumption of green and yellow fresh leafy vegetables and fruits. It is a great opportunity to make effort of female labor in the homestead vegetables production because in Bangladesh, female labors are not interested to work with male in the crop field. With the ever-increasing problems of malnutrition and not much land devoted to vegetables production, the only feasible option particularly for the small holder is to grow vegetables intensively in homestead. Household residues are organic decomposed fertilizer which can easily be used in homestead vegetables production. With this scope the vegetables and fruits cultivation program at homestead area were carried out at different Farming Systems Research and Development (FSRD) Sites, following respective site wise homestead model.

Objectives

i) To utilize homestead resources in scientific way for producing fresh vegetables and fruits.

ii) To ensure vegetables and fruits round the year from homestead and improve family nutrition as well as income of the family.

iii) To utilize women labor in income generating activities.

Methodology: The vegetables cultivation program at homestead area was carried out at five Farming Systems Research and Development (FSRD) sites of BARI i.e., Ajoddhapur (Rangpur), Ganggarampur (Pabna), Sholakundu (Faridpur), Atia, Delduar (Tangail) and Tarakandi (Sherpur) following the below models during the years of 2018 to 2021. Before initiation of activities, an individual case study of each household was conducted to identify the resource base and potentials of different farm category. Finally, twelve households from marginal, small and medium categories farmers were selected for this program. The vegetables were grown according to respective site-wise homestead model (Ferdous *et al.,* 2016). The FSRD site team provided technical assistance to the co-operator farmers regularly to cultivate vegetables

successfully.There were three to five beds in the open sunny space. Each bed size was 5 m × 1 m. Recommended seed rate, spacing and fertilizer doses were used for all the vegetables. When the vegetables were harvested, the data were recorded for each crop. Finally, the data were averaged. The product value was calculated by using the local market price of each crop.

Besides, homestead vegetables production each farmer was supplied saplings of quick growing fruit trees (Papaya, Mango, Litchi, Guava, Coconut, Ber, Lemon, Dragon fruit, Malta etc.) during the years of 2018 to 2021. On the basis of farmers' choice, agro-ecological suitability and human nutrition requirement, the fruits saplings were supplied and plantation were done in the homestead area and nearby homestead area. In Rangpur, a sole Dragon fruit orchard and a mixed fruit garden with Mango, Guava and Litchi were established. Mixed fruit garden was also established at Pabna. Irrigation, fertilization, pest control and other management of new and existing fruit trees were undertaken in this program.

Key findings

- Year-round vegetables production through respective models or modified models developed in the homestead areas of different FSRD sites created remarkable impact on availability, intake, and family nutrition for the households. With the consideration of time and space, the fallow and under-utilized homestead areas were utilized scientifically. In the vegetable production system Goyeshpur model utilized maximum niches and minimum seven niches were utilized in Palima model. Across the different FSRD sites, the average vegetable production was maximum (274 kg homestead^{-1}) in Rabi season followed by Kharif-1 (166 kg homestead^{-1}) and Kharif-2 (165 kg homestead^{-1}) season. However, round the year total vegetables produced maximum at Goyeshpur, Pabna (909 kg homestead^{-1}) followed by Sholakundu, Faridpur (706 kg homestead^{-1}) and minimum at Tarakandi, Sherpur (341 kg homestead^{-1}). After intervention of the improved technologies, vegetables production was increased maximum at Atia, Tangail (1000%) and minimum at Ganggarampur, Pabna (129%) compared to before intervention of the program.
- The average vegetables consumption per year per farm family was 463 kg after program intervention and the increment was 388%, whereas consumption was only 95 kg per farm family per year before program intervention.vegetables consumption by 5 member's farm family was on an average 303, 261, 325, 219 and 161 g head^{-1} day^{-1} after program intervention in case of Pabna, Rangpur, Faridpur, Tangail and Sherpur, respectively and the distribution of vegetables per year was recorded as 69, 24,35, 32 and 15 kg and selling of vegetables per year was 287, 69, 77, 83 and 33 kg in Pabna, Rangpur, Faridpur, Tangail and Sherpur, respectively.The gross margin attained from vegetables sector after program intervention as Tk. 10457, 8649, 9334, 3594 and 5042 at Ganggarampur, Pabna; Ajoddhapur; Rangpur; Faridpur; Atia, Tangail and Tarakandi, Sherpur, respectively, with the average gross margin of Tk. 7415 and the average increment of 376%.
- Management of existing fruit trees and new plantation of quality saplings increased availability of fruits round the year which may fulfil the requirement of family nutrition of the farm households. Higher quantity of average fruits production was found in Kharif-1 (251 kg homestead^{-1}) season followed by Kharif-2 (161 kg homestead^{-1}) and Rabi (87 kg homestead^{-1}) season. However, round the year total fruits were produced maximum at Ganggarampur, Pabna (1225 kg homestead^{-1}) and minimum at Atia, Tangail (94 kg homestead-^{1}). After implementation of the program, the fruits production was increased and it was maximum at Tarakandi, Sherpur (1580%) and minimum at Ganggarampur, Pabna (47%) compared to before intervention of the program.
- Participation of women in different farming and socio-economic activities ensured employment, changed their attitude towards decision making process in the family as well as made positive effect on equity within the family.

Key words: Home garden, safe vegetables, fruits, homestead model, nutrition

12.1.2. Year round vegetables production in homestead at FSRD site Tengra, Sreepur, Gazipur

Title: Year round vegetables production in homestead

Background: In the Madhupur Tract region cultivation of vegetables is difficult compared to other areas of Bangladesh. In this area, usually farmers do not cultivate vegetables commercially even the homestead area remains unused. Only a few farmers have interest to produce vegetables for their own consumption at very minimum scale.

Objectives:

a) Production of high value vegetables in fallow land of homestead with a view to increase income.

b) To utilize homestead resources in scientific way for producing fresh vegetables.

c) To meet up the nutrient requirements of the family members throughout the year and enhance the women empowerment.

Methodology: The activity was conducted at the FSRD site Tengra, Sreepur, Gazipur during 2018-2021. BARI developed 'Goyeshpur' model was used in Sreepur, FSRD site of BRRI for year round vegetables production at homested. Seeds of different vegetables were distributed among twelve farmers. For implementing Goyeshpur model, four beds were prepared by each farmer. Intercultural operation and management practices were done by the farmers following recommended practices. During kharif season sweet gourd, bottle gourd, bitter gourd, red amaranth and stem amaranth were sown in bed. On the other hand, during rabi season spinach, country bean, cucumber, red amaranth, radish, tomato, and pat shak were distributed among 12 farmers.

Key findings: Vegetables production and income was increased after intervention. Consumption, distribution and selling of vegetables increased about 92%, 19% and 85%, respectively. After intervention income was increased about 54% per farmer. Fruits production from other places of homestead was also increased about 51%.

Key words: Goyeshpur model, vegetables, homestead, consumption, income.

12.1.3. Performance of turmeric and ginger production under fruit tree based agro forestry system near by homestead

FSRD site Tengra, Sreepur, Gazipur (BRRI)

Title: Performance of turmeric and ginger production under fruit tree based agro forestry system near by homestead

Background: Turmeric is a spice that comes from the turmeric plant. It has warm and bitter taste and is frequently used for flavor or color as curry powder. The root of turmeric is also used widely to make medicine. It contains a yellow-colored chemical called curcumin, which is often used to color foods and cosmetics. Ginger is a plant with leafy stems and yellowish green flowers. The ginger spice comes from the roots of the plant. Ginger is commonly used for various types of "stomach problems." Both turmeric and ginger are very essential ingredient for our daily foods. These crops are shade loving (Sciophyte) in nature. In Madhupur Tract region there are many orchards of mango, jackfruit and other fruits. These fruits are seasonal and the land under the orchard remains fallow more or less round the year.

Objectives:

i) To utilize the fallow land under orchard

ii) To increase the total productivity of orchard

Methodology: The study was conducted at the FSRD site Tengra, Sreepur, Gazipur during 2018-2021. Three farmers were selected from FSR&D site for the production of ginger and turmeric in fallow land under mango and litchi orchard. The size of the plot was 20 m × 20 m. Total area was divided into two plots for turmeric and ginger cultivation. After preparing land, sowing was done by maintaining 50 cm x 25 cm and 60 cm x 25 cm spacing for ginger and turmeric, respectively. "Pilaitola" (Harvesting of mother ginger) of ginger was done at 50-60 days after sowing.

Key findings: Average production of ginger and turmeric was 8.5 t ha^{-1} and 20.33 t ha^{-1} during 2019-20. Total cost for the production of ginger and turmeric was about Tk. 2, 50,000 ha^{-1} and Tk. 1,95,000 ha^{-1} respectively. Considering the gross margin, the highest average gross margin was obtained from ginger Tk. 6, 00,000 ha^{-1} followed by turmeric Tk. 3, 13,000 ha^{-1}.

Key words: Turmeric, ginger, gross margin, orchard

12.1.4. Performance of chewing type sugarcane cultivation in homestead

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Performance of chewing type sugarcane cultivation in homestead

Background: Sugarcane is an excellent source of iron especially for children, pregnant women and their fetus. It also contains considerable amount of Ca, Mg, K and Mn. Chewing type canes are very popular now a days in our country. It is easier to consume due to its softness. Sugarcane cultivation is very easy, technically sound and widely adaptable. During heavy rainfall and flood, sugarcane can sustain in the field. Recently BSRI released some new varieties of chewing type sugarcane. These varieties grow well in the highland even in the homestead area. To evaluate the performance of those varieties in homestead, an activity was undertaken at the FSRD site Tengra, Sreepur, Gazipur.

Objectives:

i) To utilize the fallow land in the homestead

ii) To increase nutrition and income of the farmers

Methodology: The activity was conducted during 2018-2021 at the FSRD site Tengra, Sreepur, Gazipur. Saplings of three varieties (Amrita, Turag, Rongbilash) of chewing type sugarcane were collected from BSRI, Ishurdi, Pabna. A total of 20 settling were distributed to each of 12 selected farmers during the December in two consecutive years. Four pits were prepared and five settling per pit were planted. Intercultural operations and management practices was done as and when necessary. Harvesting was done about 9 months after planting in each year.

Key findings: The highest number of cane was harvested from Turag (575 per year) followed by Rongbilash (467). Considering number of cane production per seedling, maximum number of cane (7 cane per clump) produced from Turag followed by Rongbilash (5 cane per clump) and Amrita (4 cane per clump).

Key words: Chewing type, sugarcane, homestead, income.

12.1.5. vegetables production nearby homestead

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: vegetables production nearby homestead

Background: Fallow-Fallow-T. Aman is one of the most dominant cropping patterns of Sreepur, Gazipur. Farmers grown T. Aman rice in high land condition. Thus, rice cultivation is costly due to high input and labour cost as well as market value of rice is not satisfactory. On the other hand, vegetables gives much more benefit to the farmers than the other field crops. Vegetables can play a vital role in elevating the nutritional status of the rural people who suffer from severe malnutrition. Production of vegetables varies depending on crop, variety, time, place and season.

Objectives:

i) To intensify the single T. Aman area

ii) To increase farmers' income

Methodology: The activity was conducted during 2019-20 at the FSRD site Tengra, Sreepur, Gazipur. In the rabi seasonvegetables like bottle gourd, cabbage, cauliflower and tomato were cultivated followed by brinjal, chilli, amaranth and sponge gourd during kharif season. The total size of the plot was 0.12 ha.

Previously this land was used for T. Aman rice cultivation. Seeds of different vegetables and fertilizers were supplied to the farmers. Intercultural operation and management practices were done by the farmers following recommended practices.

Key findings: Maximum yield was obtained from bottle gourd (23670 kg/ha) in rabi season and brinjal (13260 kg/ha) in kharif-2 season. Minimum yield was observed in tomato during rabi season and chilli in kharif-2 season. The highest net return (Tk. 205307 /ha) was obtained from rabi season followed by kharif-2 (Tk. 147574 /ha).

Key words: Vegetables, Net return, Nearby homestead and Yield.

12.1.6. Improvement of existing fruit trees management in homestead

FSRD Site: Sreepur, Gazipur (BRRI)

Title: Improvement of existing fruit trees management in homestead

Background: Benchmark survey data reveal that mango and jackfruit are the dominant fruit trees of the site. But mango hopper was one of the most serious pests in the area. Anthracnose and powdery mildew also cause a huge loss of mango and jackfruit every year. Mango trees are notoriously susceptible to powdery mildew and anthracnose, fungal pathogens that wreak havoc on new flowers and fruits. On the other hand, jackfruit trees are vulnerable to leaf spot, fruit rot, and viral pathogens that bring may hamper on new flowers and fruits. If applied before disease sets in, fungicide and insecticide sprays can be effective as preventing fungicide and insecticide.

Objectives:

i) To increase fruit production

ii) To increase nutrition uptake and income of farmers'

Methodology: Chemical flower-inducing sprays were used to encourage higher fruit yields. By mixing both Rivcord 250 EC and Tilt 250 EC were sprayed in the mango trees with the help of foot pump sprayer. On the other hand, Sumithion 50 EC was sprayed in the jackfruit trees. After two weeks of first spray, only Ripcord 250 EC was sprayed in mango and Sumithion 50 EC was sprayed in jackfruit trees. About 200 mango and 160 jackfruit trees were sprayed at the FSRD site, Sreepur, Gazipur in January 2020. Unsprayed plants were used as control treatment for data collection and comparing the results.

Key findings: On an average, each plant produced 72.0 kg mango which was 50% higher than non-sprayed plants of the base year. Each farmer gained an extra income of Tk.1200 per plant (average). On the other hand, on an average 23 jackfruits per plant was harvested where the average production per plant was 16 in non-sprayed plant. On an average about 280 Tk. per plant income increased after spraying in jackfruit plants.

Key words: Mango, jackfruit, spraying, production, income

12.1.7. Year Round Vegetables Production in Farmer's Homestead Area

FSRD Site: Mokamia, Fulpur, Mymensingh (BFRI)

Title: Year Round Vegetables Production in Farmer's Homestead Area

Background: Nutritional problem can be reduced by regular consumption of green and yellow fresh leafy vegetables and fruits. It is a great opportunity to make effort of female labor in the homestead vegetables production because in Bangladesh, female labors are not interested to work with male in the crop field. The only feasible option particularly for the small holder is to grow vegetables intensively in homestead. Household residues are organic decomposed fertilizer which can easily be used in homestead vegetables production.

Objectives:

i) To utilize homestead resources in scientific way for producing fresh vegetables

ii) To ensure vegetables production round the year from homestead and improve family nutrition as well as income of the family.

iii) To utilize women labor in income generating activities.

Methodology: For year round homestead vegetables production 12 farmers (Twelve homestead gardens) were selected at FSRD Site Mokamia, Fulpur, Mymensingh. The activity was carried out from 1st week of April, 2018 to January 2021. The average size of each homestead garden (plot) was about 5 decimal. The gardens were fenced with nylon net after the final land preparation. Five to ten vegetables beds were prepared by covering the one-fourth to half of the total plot area and the rest area of the plot was used for vine type vegetables production in roof tops. During final land preparation 20 kg of cowdung, 2 kg of Triple Super Phosphate (TSP) and 2 kg of Muriate of Potash (MoP) were applied to each bed. Besides homestead gardening different fences of the homestead were used for vegetables production. Generally the short height vegetables like Brinjal, Cabbage, Carrot, Tomato, Radish and Red amaranth were produced in the beds of Rabi season and different types vegetables like Indian Spinach, Ladies finger, Wax Gourd and Sweet Gourd in fence of Kharif -1 season. While, in Kharif -2 seasons, Bitter Gourd and Yard long bean were cultivated in trellis. High Yielding Varieties (HYV) was used to get higher production. Different plant protection measures were taken whenever necessary. Emphasis was given on organic vegetables production.

Key findings: After intervention, the vegetables production was 2536 kg per homestead where as it was 1392 kg before intervention. The gross return, variable cost and gross margin were calculated as Tk. 59167, Tk. 15241 and Tk. 43508, respectively. The average gross margin /farmer/year was Tk. 43508 while monthly average gross margin per farmer was Tk. 3625. It was found that the income as well as intake of vegetables increased.

Key words: Homestead, Vegetables, open space and trellis, Gross return, Variable cost, and Gross margin

12.2. Improvement of crops and cropping system

12.2.1. Improvement or development of alternate Cropping Pattern instead of existing Cropping Pattern (5 FSRD sites of BARI)

Title: Improvement or development of alternate Cropping Pattern instead of existing Cropping Pattern

Background: Incorporating short duration crops like; Mustard, Sesame, Boro and Aus rice in the rice-based cropping pattern may be an option. Sustainable crop production in Bangladesh through improvement of cropping pattern in rice-based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and creation of job opportunity. In the pace of per capita land availability decrease and production shortage the existence of fallow land in rice-based cropping system is very inconsistent to national perspective. However, cereal crop production is nearby self-sufficient but there is acute shortage in other crop production. Different institutes under NARS system have developed a number of high yielding and/or short duration crops varieties, which are suitable for increasing cropping intensity and productivity. In order to produce more food within a limited area, the study on cropping pattern development or improvement was undertaken to evaluate the feasibility of growing three to four crops in respect of productivity and in a year in a piece of land by incorporating new crops in the existing cropping pattern is under taken.

Objectives

i) To increase the cropping intensity producing three or more crops over the same piece of land in a year,

ii) To increase the production efficiency of the individual crop by using improved varieties and optimum management practices,

iii) To increase farmer's income and employment opportunity in agriculture.

Methodology: To increase crop productivity, two to three cropping patterns were considered for development at each FSRD site under plainland eco-system. The T. Aman (Binadhan-17)-Mustard (BARI Sarisha-14)-Boro (BRRI dhan28) pattern against T. Aman (Swarna)-Fallow-Boro (BRRI dhan28) and the

T. Aus (BRRI dhan48)-T. Aman (Binadhan-17)-Potato (BARI Alu-8)/Sweet gourd (BARI Hybrid Misti Kumra-1) pattern against T. Aman (Swarna)-Potato (BARI Alu-8)-Boro (BRRI dhan28) were tested at FSRD site Ajoddhapur, Rangpur. The T. Aman (Binadhan-17)-Mustard (BARI Sarisha-17)-Boro (BRRI dhan28) pattern against T. Aman (BRRI dhan39)-Mustard (Tori-7)-Boro (Toba Boro) and the T. Aman (Binadhan-17)-Lentil (BARI Masur-8)-Sesame (BARI Til-4) pattern against T. Aman (BRRI dhan39)-Lentil (BARI Masur-6)-Sesame (BARI Til-3) were tested at FSRD site Ganggarampur, Pabna. The Lentil (BARI Masur-8)-Jute (Rabi-1)- T. Aman rice (Binadhan-17/BRRI dhan75) pattern against Lentil (Local)- Jute (JRO524)- T. Aman rice (BRRI dhan39) and the Mustard (BARI Sarisha-17/18)- Jute (Rabi-1)-T. Aman rice (Binadhan-17/BRRI dhan75) pattern against Mustard (Tori-7)-Jute (JRO524)- T. Aman rice (BRRI dhan39)was tested at FSRD site Sholakundu, Faridpur. The Boro (BRRI dhan29)-T. Aman rice (BRRI dhan72)-Mustard (BARI Sarisha-14) pattern against Boro (BRRI dhan29)-T. Aman rice (BR11)-Mustard (BARI Sarisha-14) and the Okra (BARI Dherosh-2)-T. Aman rice (BRRI dhan72)-Cabbage (Autumn queen) pattern against Brinjal (Singhnath)-T. Aman rice (BR11)-Cabbage (Autumn queen) were tested at FSRD site Atia, Tangail. The T. Aman (BRRI dhan49)-Potato (BARI Alu-25)-Mungbean (BARI Mung-6)-T. Aus (BRRI dhan48) pattern against T. Aman (Hori)-Fallow-Boro (BRRI dhan29) and the T. Aus (BRRI dhan48) - T. Aman (BRRI dhan49)-Motor shuti (BARI Motor shuti-3)-Boro (Hybrid shakka) pattern against T. Aman (Hori dhan)-Fallow-Boro (BRRI dhan29) were tested at FSRD site Tarakandi, Sherpur.

Key findings

1. Existing cropping pattern: T. Aman (Swarna)-Fallow-Boro (var. BRRI dhan28)

Improved cropping pattern: T. Aman (var. Binadhan-17)-Mustard (var. BARI Sarisha-14)-Boro (var. BRRI dhan28)

The whole pattern rice equivalent yield was 18.53 and 10.81 t ha^{-1} in improved and existing cropping pattern, respectively. The whole pattern gross margin was calculated Tk. 98588 and 31540 ha^{-1} in improved and existing cropping pattern, respectively. The MBCR was calculated 3.14 in improved cropping pattern over existing cropping pattern.

2. Existing cropping pattern: T. Aman (Swarna)-Potato (var. BARI Alu-8)-Boro (var. BRRI dhan28)

Alternative cropping pattern: T. Aus (var. BRRI dhan48)-T. Aman (var. Binadhan-17)-Potato (var. BARI Alu-8)/Sweet gourd (var. BARI Hybrid Mistikumra-1)

The whole pattern rice equivalent yield was 51.39 and 24.98 t ha^{-1} in improved and existing cropping pattern, respectively. The whole pattern gross margin was higher in improve pattern (Tk. 403064 ha^{-1}) than existing pattern (Tk. 106820 ha^{-1}). The MBCR was calculated 8.31 in improved cropping pattern over existing cropping pattern.

3. Existing cropping pattern: T. Aman (var. BRRI dhan39)-Mustard (Tori-7)-Boro (Toba Boro)

Improved cropping pattern: T. Aman (var. Binadhan-17)-Mustard (var. BARI Sarisha-17)-Boro (var. BRRI dhan28)

The whole pattern rice equivalent yield was 16.77 and 11.77 t ha^{-1} in improved and existing cropping pattern, respectively. The whole pattern gross margin was higher in improve pattern (Tk. 95300 ha^{-1}) than existing pattern (Tk. 25300 ha^{-1}). The MBCR was calculated 4.5 in improved cropping pattern over existing cropping pattern.

4. Existing cropping pattern: T. Aman (var. BRRI dhan39)-Lentil (var. BARI Masur-6)-Sesame (var. BARI Til-3)

Improved cropping pattern: T. Aman (var. Binadhan-17)-Lentil (var. BARI Masur-8)-Sesame (var. BARI Til-4)

The yield T. Aman rice, Lentil and Sesame were 5.50, 1.60 and 1.50 t ha^{-1} in improved cropping pattern and 4.50, 1.10 and 1.20 t ha^{-1} in existing cropping pattern, respectively. The whole pattern rice equivalent

yield was 15.41 and 11.86 t ha^{-1} in improved and existing cropping pattern, respectively. The whole pattern gross margin was higher in improved pattern (Tk. 123320 ha^{-1}) than existing pattern (Tk. 68650 ha^{-1}). The MBCR was calculated 6.86 in improved cropping pattern over existing cropping pattern.

5. Existing cropping pattern: Lentil (Local)- Jute (JRO524)- T. Aman rice (var. BRRI dhan39)

Improved cropping pattern: Lentil (var. BARI Masur-8)-Jute (Rabi-1)- T. Aman rice (var. Binadhan-17/BRRI dhan75)

The whole pattern rice equivalent yield was 18.66 and 14.64 t ha^{-1} in improved and existing cropping pattern, respectively. The whole pattern gross margin was Tk. 170851 and 107034 ha^{-1} for improved pattern and existing pattern respectively. The MBCR of improved cropping pattern was 2.65.

6. Existing cropping pattern: Mustard (Tori-7)-Jute (JRO524)- T. Aman rice (var. BRRI dhan39)

Improved cropping pattern: Mustard (var. BARI Sarisha-17/18)- Jute (Rabi-1)-T. Aman rice (var. Binadhan-17/BRRI dhan75)

The whole pattern rice equivalent yield was 17.34 and 13.95 t ha^{-1} in improved and existing cropping pattern, respectively. Whole pattern gross margin was Tk. 140331 and 97055 ha^{-1} for improved pattern and existing pattern respectively. The MBCR was calculated 2.25 in improved cropping pattern over existing cropping pattern.

7. Existing cropping pattern: Boro (var. BRRI dhan29)-T. Aman rice (var. BR11)-Mustard (var. BARI Sarisha-14)

Improved cropping pattern: Boro (var. BRRI dhan29)-T. Aman rice (var. BRRI dhan72)-Mustard (var. BARI Sarisha-14)

The whole pattern rice equivalent yield was 16.75 and 13.91 t ha^{-1} in improved and existing cropping pattern, respectively. It was observed that the higher total gross margin (Tk. 102810 ha^{-1}) and MBCR (4.49) was obtained from improved cropping pattern.

8. Existing cropping pattern: Brinjal (Singhnath)-T. Aman rice (var. BR11)-Cabbage (Autumn queen)

Improved cropping pattern: Okra (var. BARI Dherosh-2)-T. Aman rice (var. BRRI dhan72)- Cabbage (Autumn queen)

The whole pattern rice equivalent yield was 42.21 and 35.11 t ha^{-1} in improved and existing cropping pattern, respectively. The higher whole pattern gross margin Tk. 363920 ha^{-1} and MBCR 3.71 was obtained from improved cropping pattern.

9. Existing cropping pattern: T. Aman (Hori)-Fallow-Boro (var. BRRI dhan29)

Alternative cropping pattern: T. Aman (var. BRRI dhan49)-Potato (var. BARI Alu-25)-Mungbean (var. BARI Mung-6)-T. Aus (var. BRRI dhan48)

The whole pattern rice equivalent yield was 29.99 and 9.59 t ha^{-1} in alternative cropping pattern and existing cropping pattern, respectively. It was observed that the highest gross return (Tk. 524950 ha^{-1}), gross margin (Tk. 221618 ha^{-1}) and MBCR (1.93) was obtained from alternative cropping pattern.

10. Existing cropping pattern: T. Aman (Hori dhan)-Fallow-Boro (var. BRRI dhan29)

Alternative cropping pattern: T. Aus (var. BRRI dhan48) -T. Aman (var. BRRI dhan49)-Motor shuti (var. BARI Motor shuti-3)-Boro (Hybrid shakka)

The whole pattern rice equivalent yield was 29.51 and 10.37 t ha^{-1} in alternative cropping pattern and existing cropping pattern, respectively. It was observed that the highest gross return (Tk. 512275 ha^{-1}), gross margin (Tk. 283215 ha^{-1}) and MBCR (1.80) were obtained from improved cropping pattern.

Key words: Cropping pattern, Crop productivity, Cropping intensity, Rice equivalent yield

12.2.2. Improvement of the existing Boro-Fallow-T. Aman cropping pattern through inclusion of oil seed and pulse crops

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Improvement of the existing Boro-Fallow-T. Aman cropping pattern through inclusion of oil seed and pulse crops

Background: There is very little scope to increase the area under rice cultivation rather there is a great demand to release some land for non-rice crops to meet the diversified needs of the farmers. So, it is essential to increase the productivity of rice and non-rice crops by utilization of fallow period in the cropping pattern. Mustard is one of the most important oil seed crops in Bangladesh and now-a-days is successfully cultivated in wet-dry transition period between T. Aman and Boro in many locations of the country. BARI has developed short duration, pest and disease resistant mustard and mungbean varieties which are agro economically suitable and profitable.

Objectives:

a) To validate different cropping patterns by introducing short duration variety of mustard, mungbean.

b) To increase land productivity by introducing new crops in the existing pattern.

c) To increase overall farm income.

Methodology: The experiment was conducted during 2018 to 2020 with two improved cropping patterns viz., CP2: Mustard-Boro-T. Aman, CP3: Mustard-Mungbean-T. Aus-T. Aman were tested against existing CP1: Boro-Fallow-T. Aman cropping pattern. Rice variety BRRI dhan84 was used in Boro season. BRRI dhan48 was used in T. Aus and BRRI dhan71 was used in T. Aman season. In case of mustard and mungbean; BARI Sorisha-14 and BARI Mung -6 were used, respectively.

Key findings: Improved patterns (2) were tested and 219-367% higher gross margin was found than the existing cropping pattern. About 77-78% REY was increased in improved cropping pattern than the existing cropping pattern.

Key words: REY, Gross margin, Yield, Improved pattern, Farm income.

12.2.3. An improved cropping pattern for highland in Madhupur tract soil: Mustard-Mungbean-T. Aus-Blackgram

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: An improved cropping pattern for highland in Madhupur tract soil: Mustard-Mungbean-T. Aus-Blackgram

Background: To bring this area under full fledge cultivation round the year, different upland crops and a rice crop was planned to cultivate in 4-crop cropping pattern and a new 4-crop cropping pattern was developed. Short duration varieties of crops were selected to fit well in the improved cropping pattern. In this cropping pattern, in Rabi season mustard is cultivated which is followed by mug bean. After mug bean, late T. Aus rice is cultivated which is little pushed towards rainy season so that it can receive enough rainfall in rainy season. After T. Aus harvest, black gram is cultivated. Thus a new cropping pattern, Mustard-Mug bean-T. Aus-Black gram is developed with diverse crop combination where two different pulses, one oil seed crop and one cereal are included.

Objective:

i) To increase the system productivity and farmer's income

Methodology: The experiment was conducted in two consecutive years with improved cropping patterns: Mustard-Mungbean-T. Aus-Blackgram was tested against farmers existing Fallow-Fallow-T. Aman cropping pattern. Rice variety BRRI dhan48 was used in Aus season. BARI Sarisha-14, BARI Mung-6 and BARI Mash-4 were used in case of mustard, mungbean and blackgram, respectively. Average size of the

plot was one bigha (35 decimal) per farmer. Recommended management practices were followed for different crops. The yield of each crop was converted to rice equivalent yield for comparing the system productivity.

Key findings: Improved cropping pattern were tested where 196% and 385% higher rice equivalent yield (REY) was found than the existing cropping pattern. Gross margin 67,020 and 72,240 Tk./ha was obtained from the improved cropping pattern during 2018-19 and 2019-20, respectively over the existing cropping pattern.

Key words: Madhupur Tract, Cropping pattern, Gross margin, Rice Equivalent Yield.

12.3. On-Farm Verification/Production Program

12.3.1. On-Farm Verification/Production Program with improved varieties at farmers level of FSRD sites BARI

Title: On-Farm Verification/Production Program with improved varieties at farmers field

Background: Bangladesh Agricultural Research Institute and other NARS Institutes have developed a large number of modern varieties of different crops, which are high yielder as well as short in duration. To identify the suitable crops and varieties, on-farm verification trial was conducted during 2018-2021 with different types of crops e.g., Mustard, Potato, Tomato, Wheat, Mungbean, Sesame, Lentil, Barley, Okra, Radish, etc. The identified suitable varieties were brought under production program at each location during the following years. The production program is the simplest and popular way of technology dissemination and farmer's motivation.

Objectives

1. To create impact in the locality on high yielding crops and varieties
2. To increase productivity and farmers income

Methodology: Production program with Mustard, Potato, Tomato, Lentil, Wheat, Mungbean, Sesame, Radish, Barley and Okra were conducted at 5 FSRD sites of BARI i.e., Ajoddhapur (Rangpur), Ganggarampur (Pabna), Sholakundu (Faridpur), Atia, (Tangail) and Tarakandi (Sherpur) during the years of 2018 to 2021. Recommended crop management practices were followed for crop production.

Key findings: On-farm verification with 15 high yielding crop varieties of 8 important crops showed better performance in terms of earliness higher yield and gross return. This program has created positive impact on total income enhancement.

Location: FSRD site, Ajoddhapur, Rangpur

Mustard: The mean seed yield of BARI Sarisha-14 and BARI Sarisha-18 were 1.62 and 1.59 t ha^{-1}, respectively. The gross margin was Tk. 41530 and 40258 ha^{-1}, respectively.

Tomato: BARI Tomato-15 and BARI Tomato-18 seedling was produced and supplied by the LSP to other farmers, who bought it at reduced price. The fruit yield of produced Tomato were 82.27 and 82.32 t ha^{-1} with the gross margin of Tk. 604700 and 605200 ha^{-1} in case of BARI Tomato-15 and BARI Tomato-18, respectively.

Potato: The average tuber yield of Potato were 30.00 and 29.62 t ha^{-1} and estimated gross margin were Tk. 170200 and 170000 ha^{-1} in case of BARI Alu-25 and BARI Alu-53, respectively.

Location: FSRD site: Ganggarampur, Pabna

Mustard: The seed yield of Mustard (BARI Sarisha-17) was 1.95 t ha^{-1} and calculated gross margin was Tk. 42062 ha^{-1}.

Lentil: The seed yield of Lentil (BARI Masur-8) was 1.58 t ha^{-1} and gross margin was Tk. 71500 ha^{-1}.

Turmeric: The corm yield of Turmeric was 14.5 t ha^{-1}. Gross margin was calculated Tk.119750 ha^{-1}.

Pea: The seed yield of pea (BARI Motor-3) was 2.07 t ha^{-1} and gross margin was Tk. 122080 ha^{-1}.

Onion: The bulb yield of Onion (BARI Piaj-2) was 12.50 t ha^{-1} and gross margin was Tk. 65000 ha^{-1}.

Location: FSRD site: Sholakundu, Faridpur

Mustard: The average seed yield of BARI Sarisha-14 and BARI Sarisha-18 were 1.76 and 1.71 t ha^{-1} and the gross margin was Tk. 27070 and 32830 ha^{-1}, respectively.

Wheat: The grain yield of BARI Gom-28 and BARI Gom-33 were 3.81 and 3.95 t ha^{-1} and gross margin was calculated Tk. 26542 and 31667 ha^{-1}, respectively.

Mungbean: The average seed yield of BARI Mung-6 and BARI Mung-8 were 0.76 and 0.69 t ha^{-1} with gross margin in Tk. 9988 and 17688 ha^{-1}, respectively.

Sesame: The mean seed yield of BARI Til-4 was 1.83 t ha^{-1}. The gross margin was Tk. 85255 ha^{-1}.

Lentil: The mean seed yield of BARI Masur-8 was 1.76 t ha^{-1}. The gross margin was Tk. 84370 ha^{-1}.

Onion: The mean bulb yield of BARI Piaj-4 was 16.22 t ha^{-1}. The gross margin was Tk. 368925 ha^{-1}.

Radish+Onionbulb+Red amaranth with Sugarcane: The Radish, Onion bulb and Red amaranth yield was 15, 2.5 and 2.6 t ha^{-1}, respectively. The gross margin was Tk. 301934 ha^{-1}.

Location: FSRD site: Atia, Tangail

Mustard: The seed yield of BARI Sarisha-14 and BARI Sarisha-17 was 1.57 and 1.65 t ha^{-1}, respectively. The gross margin was obtained Tk. 34114 and 37531 ha^{-1} from BARI Sarisha-14 and BARI Sarisha-17, respectively.

Barley: The seed yield of BARI Barley-6 and BARI Barley-7 was 1.97 and 2.05 t ha^{-1}, respectively. The gross margin was obtained Tk. 23408 and 25448 ha^{-1} from BARI Barley-6 and BARI Barley-7, respectively.

Location: FSRD site: Tarakandi, Sherpur

Mustard: The average seed yield of BARI Sarisha-14 was 1.37 t ha^{-1} and the gross margin was Tk. 31510 ha^{-1}.

Okra: The fruit yield of Okra was 28.82 t ha^{-1} with the gross margin in Tk. 144590 ha^{-1}.

Potato: The average tuber yield of Potato (BARI Aluu-41) was 40.62 t ha^{-1} with gross margin in Tk. 312298 ha^{-1}.

Key words: Farm income, Gross margin, Production, Variety, Yield

12.3.2. Production program of modern Aus rice varieties

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Production program of modern Aus rice varieties

Background: Boro-Fallow-T. Aman is the most dominant cropping pattern of the site where farmers are growing Boro rice in medium high land by irrigating more than 8-10 times in a season. Thus, Boro cultivation is costly due to high water consumption. In Bangladesh, ground water is decreasing day by day due to climate change, less rainfall, less recharge of ground water. However, with the rising water stress and erratic rainfall, Aus rice production between Rabi and Kharif-II might be an alternative way to save underground water. Production of short duration rainfed Aus rice instead of Boro is a good option to conserve ground water.

Objectives:

1. To investigate the suitability of Aus rice in the region
2. To find out suitable Aus rice variety (s) for this region and to evaluate farmers' response.

Methodology: Production program of Aus rice was carried with Aus rice varieties (viz., BRRI dhan27, BRRI dhan43, BRRI dhan48, BRRI dhan65, BRRI dhan82, BRRI dhan83 and BRRI dhan85). Date of seeding, transplanting, weeding, fertilization and harvesting were done according to BRRI recommendation.

Key findings: BRRI dhan48 performed better compared to all other tested Aus rice varieties. The gross margin Tk. 46,280 ha^{-1}, Tk. 32440 ha^{-1} and Tk. 29600 ha^{-1} was found from BRRI dhan48 during Aus season 2018, 2019 and 2020, respectively.

Key words: Aus, Rice, Variety, Yield, Gross margin

12.3.3. Production program of modern Aman rice in Madhupur Tract

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Production program of modern Aman rice in Madhupur Tract

Background: Aman rice is one of the main crops in the site. Farmers are practicing local varieties along with high yielding old varieties in this season. BRRI recently released some varieties with higher yield performance were used for increasing overall productivity of the farm with the following objectives:

a) To increase total productivity of land by replacing local rice variety with high yielding variety.
b) To increase overall farm income.
c) To determine the field performance of newly BRRI released Aman varieties in this region.

Methodology: The activity was conducted at FSRD site Tengra, Sreepur, Gazipur during 2018 to 2020 with Aman rice varieties (viz., BRRI dhan57, BRRI dhan71, BRRI dhan72, BRRI dhan75, BRRI dhan80 and BRRI dhan87). Management practices were done according to BRRI recommendation.

Key findings: It was observed that Aman var. BRRI dhan71, BRRI dhan75 and BRRI dhan87 performed better compared to all other tested Aman rice varieties during 2018, 2019 and 2020, respectively. The gross margin Tk. 30,480 ha^{-1}, Tk. 30,240 ha^{-1} and Tk. 21,800 ha^{-1} was found from BRRI dhan71, BRRI dhan75 and BRRI dhan87, respectively.

Key words: Aman, rice, yield, variety, gross margin

12.3.4. Production program of modern Boro rice varieties

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Production program of modern Boro rice varieties

Background: Boro rice is one of the main crops in Sreepur, Gazipur region. Farmers are practicing local varieties along with old varieties in this season. Yield performance of these varieties is comparatively low. BRRI released some varieties with higher yield performance than the previous varieties.

Objective:

a) To increase total productivity of land by replacing local rice variety with high yielding variety.
b) To increase overall farm income.
c) To determine the field performance of newly BRRI released Boro varieties in this region.

Methodology: The study was conducted during 2018 to 2020 with different Boro rice varieties (viz., BRRI dhan28, BRRI dhan50, BRRI dhan63, BRRI dhan67, BRRI dhan69, BRRI dhan74, BRRI dhan81, BRRI dhan84 and BRRI dhan88). Management practices were done according to BRRI recommendation.

Key findings: It was found that Boro var. BRRI dhan50 performed better compared to all other tested varieties during Boro season. The gross margin Tk. 46,800 /ha and Tk. 56,850 /ha was found from BRRI dhan50 during Boro season in 2018-19 and 2019-20, respectively.

Key words: Boro, Variety, Rice, Yield, Gross margin

12.3.5. Organic Production of HYV Cucumber (Field King)

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

Title: Organic Production of HYV Cucumber (Field King)

Background: Cucumber (Cucumis sativus) a member of the Cucurbitaceae family, is a popular fresh market vegetables in Bangladesh. The crop is very much susceptible to different pests and diseases viz. cucumber fruit fly, whitefly, melon fly, leaf miners, mosaic viruses etc. In controlling diseases and pests, indiscriminate use of the agro chemicals is polluting environment and reducing the soil health statue day by day. Organic production of crops can reduce this environmental hazard in a considerable extent.

Objectives:

- ✓ to reduce the use of agro-chemicals as well as the environmental pollution;
- ✓ to reduce the production cost

Methodology: For Cucumber production, three farmers having relatively high land of sandy loam textured soil was selected. The average size of each plot was 15 decimal. During the final land preparation 500 kg (@ 8 t/ha) of cowdung, 12 kg of TSP (@ 200 kg/ha) and 12 kg of MoP (@ 200 kg/ha) were applied to the soil. Urea was applied after 15 and 30 days of seeding in two installment @ 200 kg/ha. After 2 days of bed preparation, HYV cucumber's (var. Field King) seeds were sown directly to the soil in dibbling method. A trelly of 2.5ft height was made over the beds with the help of rope supported by bamboo poles. Mechanical (hand picking) and biological (perching) methods were used for pest control. Harvesting of cucumber was started from 37 days after showing. The average production of cucumber was about 2.7 ton/15 decimal of land. Produced cucumber was used for both consumption and selling. On an average of 2.4 tons of cucumber was found to sell and the rest 300 kg was found to consume. The average net income was Tk. 29,200.

Key findings: A total of Tk. 29200 was achieved through production of 2.70 ton of cucumber. It is found that the income is being used for another vegetables production, different development activities which ultimately improving their living standard.

Key words: Organic production, Cucumber

12.4. Livestock Production System

12.4.1. Livestock rearing and their management at homestead level at FSRD sites of BARI

Title: Livestock rearing and their management at homestead level

Background: Livestock and poultry were the strongest sources of growth in Bangladesh agriculture. At the farm level, livestock raising is a major activity in rural areas. For a large proportion of smallholder households engaged in livestock raising, the activity is the primary source of income. The major portion of dietary proteins comes from livestock source. Now a day, there are some improved breeds as well as local improved poultry breed available in the locality. Sonali is improved and Garchila is treated as local improved breed for chicken. Khaki Campbell is one of the popular breeds for duck rearing. Turkey is a popular bird in American and European continent. But within a short time, it gains popularity. A number of people started turkey bird rearing in different parts of the country. Turkey farming is more profitable than poultry farming as it takes less space and less risk of diseases. The most profitable turkey farming with short time and short investment has opened the possibility of meeting the economic potential as well as meeting the needs of protein. Turkey birds mainly eat grasses and vegetables. As a result, farmers do not have to depend only on packed feed. Pigeon is a very good source of protein and rapid income generation as it is very prolific breeder and its meat is very tender and loved by all. Generally, people rear pigeon for meat purpose and the rearing rate is very low in the FSRD sites.

Vaccines are expected to reduce the severity of disease in infected animals or limit the frequency of disease. Vaccines can prevent a wide range of diseases that cause reduced production, fertility or death in cattle, goat and chicken and economic losses to the farmers. It is important to know against which diseases, animals

should be vaccinated. There are some common diseases that animals should be routinely protected. Cattle fattening and calf rearing are gaining popularity for the rapid growth of cattle. Dairy cattle reared at farmers level with no improved management, as a result the milk production is less, which may be enhanced through improved feed and management.

Objectives

- To improve farmers nutritional and socio-economic status
- To popularize improved poultry breed in the study area
- To make easy availability of egg, milk and meat in rural area

Methodology: Productivity and profitability of livestock sector mostly depend on farm animal health and maintaining of livestock health that is an integral part of integrated farming. Cattle health may be improved through deworming which may make the farmer economically benefitted. More than 10 faeces sample of cattle were selected from different location by the symptomatic parasitic infection and then investigated the parasites through faeces sample analysis for the confirmation. After confirmation of parasitic infestation, the test animal was de-wormed by broad spectrum anthelmintics i.e.,Trilev-vet (Livamisole and Triclabendazole) for round worm and liver fluke as per recommendation for the body weight. After deworming, Vitamin A, D and E containing injections were also being injected in cattle. Proper vaccination against four major diseases may reduce the mortality rate of cattle. For this purpose a short FGD was conducted to identify the disease severity and mortality after vaccination. In the vaccinated group Anthrax vaccine, Foot and mouth disease (FMD) vaccine, Black quarter (BQ) vaccine and Hemorrhagic septicemia (HS) vaccine were injected as per recommended schedule. Cattle fattening and Calf rearing programs were also continued at some areas.

Besides of cattle product, cowdung is very important by-product for integrated farming and farmers were motivated to use it for preparation of farm yard manure (FYM) and vermicompost including other homestead westage instead of using the cowdung as fuel.

Napier grass was identified as a suitable and profitable green fodder to produce in the homestead and its surrounding areas especially on pond bank. Farmers were advised to apply FYM after every cut of grass. It was introduced among the farmers under the program to produce for feeding their cattle. Some farmers were also selling their produced Napier grass in the market besides of feeding their cattle.

Poultry rearing is a common practice in rural Bangladesh. Poultry disease is the main problem faced by the farmers for poultry rearing. Only proper vaccination can reduce the mortality rate of poultry. To reduce mortality rate and investigating effectiveness of poultry vaccine at farmers' level this program was conducted at the farmer's field. A good number of poultry birds were vaccinated during the project period. In the vaccinated group BCRDV, RDV, Fowl pox, Fowl cholera and Duck plague vaccine were used as per recommended schedule. Regular contact was done by the facilitator team for providing necessary suggestions to solve their specific problems. Chick rearing, Pigeon rearing, Duck rearing and Turkey rearing programs were also conducted at some locations.

Key findings

- Vaccination against major diseases i.e., Anthrax, Foot and Mouth Disease and Black Quarter reduced disease incidence of livestock below 7% at the FSRD sites which contributed higher production and economic return from cattle farming.
- Cattle health was improved through deworming and vitamin A, D, E supplementation. The maximum body weight gain (70-100 g day^{-1} $animal^{-1}$), milk production (1.8 L day^{-1}) and lactation period (195 day) was obtained from deworming and vitamin ADE injection treated cattle followed by dewormed cattle and minimum from controlled cattle at different FSRD sites.
- Beef fattening of cattle by UMS after deworming helped to gain body weight of animals and increased the farm income. Market value was estimated and found that it was increased by 28-65%.

- Three to eight months old aged eight calf were considered under the program with improved management at FSRD site, Ganggarampur, Pabna. It was found that body weight of calf under the program, increased rapidly.
- Seven farmers were rearing goat at homestead level. The initial average body weight was 9.5 kg goat^{-1} and after 6 months the average body weight gained 4 kg goat^{-1}. On an average two kids were born per goat. The average gross margin was calculated Tk. 2033 goat-1.
- Vaccination on poultry maintaining proper schedule against Ranikhet, Fowl Cholera and Fowl Pox showed significant impact on reducing mortality rate and gave higher economic return. The mortality rate can be minimized significantly through vaccination. Mortality rate went below 10% in maximum cases which can be considered as negligible comparing to the condition before the vaccination program.
- Poultry rearing with improved breed and proper feed management exhibited higher economic return and created opportunity of employment in the rural farming.The initial weight of Sonali breed provided to the cooperator farmer was about 0.72 kg and average final body weight obtained from those chickens was about 1.38 kg. Number of eggs laid by a hen is about 48 during the considering period. The gross margin obtained per household was calculated as Tk. 4151-10349 up to seven months.
- In case of naked neck chicken, the initial weight of a bird provided to the cooperator farmer was about 0.69 kg and average final body weight obtained from those chickens was about 1.65 kg. Number of eggs laid by a hen is about 25. The gross margin per household was calculated as Tk. 5538.
- In case of duck rearing, the average body weight obtained from those ducks was 2.39-3.12 kg. The monthly income obtained from egg per household was calculated and it was about Tk. 1100-2400.
- In case of Turkey rearing, the average body weight per bird was gained about 4.65 kg. The average gross margin per farm after five months rearing was calculated as Tk. 6700.
- In case of pigeon, each farmer was reared on an average 16 number of pigeons. Average weight of the supplied pigeon was 180 g. Average 23 pairs of squabs was born after six month and the farmers kept them to add another pigeon pair and some of them were sold. Finally, total 23 pairs of squabs were borned per family. Before intervention the farmers have no pigeon and income. But due to rearing of pigeon, per farmer cash earned Tk. 2693.
- Farm Yard Manure (FYM) was produced with cowdung and household wastage. It was found that on an average 3050 kg FYM was produced per homestead after program intervention where it was only 2200 kg before intervention. It may also help to keep clean the environment of the homestead area and to produce relatively safe vegetables.
- The vermicompost was prepared with household wastage especially with cowdung. The total production of vermicompost was 320 kg homestead^{-1}. The gross margin was calculated Tk. 840 homestead^{-1}.
- Green fodder production in the homestead or nearby homestead area might be a promising technology for maintaining farmers own cattle as well as earning cash money. Napier grass production was started at farmers land nearby homestead and on the pond bank at different FSRD sites under plainland eco-system. It was found that average 53.11 t ha^{-1} green fodders could be produced from a homestead or surrounding areas.

Key words: Cattle fattening, Green fodder, Naked neck chicken, Pigeon rearing, Turkey bird, Vaccination.

12.4.2. Turkey rearing under scavenging system

FSRD site Tengra, Sreepur, Gazipur (BRRI)

Title: Turkey rearing under scavenging system

Background: Turkey is a popular bird in American and European continent. This bird was brought to our

country as a part of hobby. But within a short time, it gains popularity. A number of people started turkey bird rearing in different parts of the country. Turkey farming is more profitable than poultry farming as it takes less space and less risk of diseases. The most profitable turkey farming with short time and short investment has opened the possibility of meeting the economic potential as well as meeting the needs of protein. Turkey birds mainly eat grasses and vegetables. As a result, farmers do not have to depend only on packed feed. Besides, it can be kept in open areas, not like the poultry farm. On the other hand, turkey disease is very rare. As a result, it needs fewer medicines. There is a great demand of turkey meat in the markets, especially in the restaurants. The common peoples are now also interested in buying turkey meat. As a white meat, its quality is superior and it is delicious than any other meat. The prices are slightly higher in the market compared to other birds.

Objectives:

i) To check the feasibility of turkey rearing under rural condition

ii) To increase household income through empowering rural women

Methodology: The programme was conducted during 2018 to 2020 with fifty turkey chickens (male and female ratio of 3:7). About 7-10 day old turkey chicks were supplied to the farmers. The routine works of vaccination were followed regularly and natural feeds (grass, Gimakolmi shak, rice grain, jackfruits etc) were fed. After 5-6 months of age female birds started laying eggs. Egg production and body weight gained was monitored regularly. About 7-8 months' duration turkey birds gained commercial weight and ready to sale. Technical supports (feeding, vaccination, incubator etc) and advices were also given to the farmer. Eggs were hatched using the incubator. Conventional hatching practice was also followed in the early stage of rearing. Necessary treatment was also given as per requirement. Farmers earned money by selling egg, adult turkey and turkey chicks.

Key findings: Average 6.0 -7.0 kg body weight was increased up to twelve months of turkey rearing under scavenging system. Net income from turkey rearing was Tk. 269650, Tk. 350545 and Tk. 141550 during 2018, 2019 and 2020, respectively.

Key words: Turkey, scavenging, Net income, Hatching, Body weight

12.4.3. Rearing of Sonali chicken at Farmers' household

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Rearing of Sonali chicken at Farmers' household

Background: Modern and successful production of poultry meat contributes significantly to the agricultural economy of Bangladesh. Poultry plays a pivotal role in bridging the protein gap of animal origin in Bangladesh. Of the many foods obtained from land and sea, man tends to have a preference for animal products such as meat, milk, eggs and fish. Meat holds an important position in our daily diet. It provides palatability and is a good source of essential amino acids, vitamins and minerals. Local chicken production which is still important in low income food deficit in the state is an appropriate system to support the fast growing human population with high quality protein. Poultry meat shared second position of this meat production. Of them Sonali meat contributes a larger part of the broiler meat production. So it is important to give attention on the 'Sonali' population of the country which is especially for meat production. If we are able to improve the 'Sonali' production it will able to share more to the total meat production of the country.

Objectives:

- To improve farmers nutritional status and income
- To popularize improved poultry, breed in the study area
- To make easy availability of egg and meat in rural area

Methodology: The program was implemented with 20, 30 and 40 chicks during 2018, 2019 and 2020, respectively among the 12 farmers. About 20-25 day old chicks were supplied to the farmers. The routine

works of vaccination are being followed regularly and natural feeds were fed. Body weight gain was monitored regularly. Technical supports (feeding, vaccination etc) and advices were also given. Necessary treatment was also given as per requirement. Rearing of Sonali chickens was done for about six months in every year as by this time chickens were attained marketable size.

Key findings: Body weight increased after six months was 1.08 kg, 1185 kg and 1.26 kg respectively. Average total return per farmer was Tk. 4200, Tk. 6100 and Tk. 8400, respectively. Average gross margin per farmer in 2018, 2019 and 2020 were Tk. 49300, Tk. 56700 and Tk. 67500, respectively.

Key words: Sonali, chicken, gross margin, body weight

12.4.4. Small scale pigeon rearing in farmer's household

FSRD site Tengra, Sreepur, Gazipur (BRRI)

Title: Small scale pigeon rearing in farmer's household

Background: Pigeons have been domesticated for centuries, primarily for food production. Squabs and pigeons have no doubt been a well-linked item for food for human race since prehistoric days. But there is no record of pigeons being raised commercially as a food until the last few years. Pigeon is a very good source of protein and rapid income generation as it is very prolific breeder and its meat is very tender and loved by all. Generally, people rear pigeon for meat purpose and the rearing rate is very low in the FSRD site, Tengra, Sreepur, Gazipur. Pigeons were supplied to increase family income through squab production and to increase nutritional supply to family members.

Objectives:

- To improve farmers nutritional status and income
- To popularize pigeon rearing in farmer's household

Methodology: The activity was undertaken at the FSRD site Tengra, Sreepur, Gazipur during 2019-2020. Twelve pairs of adult pigeon were distributed to six farmers (Two pairs to each farmer) during December 2019. Local breeds of pigeons were collected from the local market. The routine works of vaccination was followed regularly and natural feed were fed. Egg, squab production and body weight gain was monitored regularly. Technical supports (feeding and watering management, vaccination etc) and advice were also given. Necessary treatments were also provided as per requirement.

Key findings: Average body weight gain per pigeon was 680 g. Average squab production was 17 per farmer during 2019-20. Farmers sold (60%) and consumed (20%) produced squab which increased their income and nutrition uptake. Pigeon rearing provides additional income of Tk. 2167 per farmer by squab production

Key words: Pigeon, Squab, Nutrition, Income, Production

12.4.5. Vaccination program for cattle, goats and chickens

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Vaccination program for cattle, goats and chickens

Background: Vaccines are expected to reduce the severity of disease in infected animals or limit the frequency of disease. Vaccines can prevent a wide range of diseases that cause reduced production, fertility or death in cattle, goat and chicken and economic losses to the farmers. It is important to know against which diseases, animals should be vaccinated. There are some common diseases that animals should be routinely protected.

Objectives:

1.To reduce mortality rate of livestock

2. To increase farmers income

Methodology: The vaccination activity was conducted at the FSRD site Tengra, Sreepur, Gazipur during 2020. Vaccination against Khuravax for cattle, PPR for goat and Ranikhet vaccine for chicken, duck and pigeon were provided on 18 January 2020. Two hundred and fifty-eight cattle, about eighty goats, three hundred and fifty chickens, ninety ducks and fifty-five pigeons were vaccinated at FSRD site. In second time, Lumpy skin disease for cattle, PPR for goat and Ranikhet vaccine for chicken, duck and pigeon were provided on 25 July 2020. Three hundred and sixty-eight cattle, one hundred and fifteen goats, four hundred chickens, one hundred and fifty ducks and one hundred and fifty pigeons were vaccinated at the FSRD site in second time vaccination programme. Data was collected accordingly.

Key findings: It was found that before vaccination, frequency of different disease were higher. After vaccination of cattle, goat, chicken, duck, pigeon and turkey, disease frequency and mortality rate reduced by 10-15%.

Key words: Vaccination, Cattle, Goat, Chicken, Mortality, Disease

12.4.6. Rearing of Jinding duck in rural condition

FSRD site Mokamia, Fulpur, Mymensingh (BFRI)

Title: Rearing of Jinding duck in rural condition

Background: Most of the people in our country are suffering from malnutrition. Main cause of malnutrition is protein deficiency. Production of eggs and meat is necessary to fulfill the deficiency of protein. It would not only provide egg and meat but also the source of income generation to the farmers. Duck rearing is very easy and simple in our rural condition. Duck rearing is easier than chick rearing due to its disease resistant character. Ducks, being an important poultry species, can contribute efficiently in increasing egg and meat production than chicken in the coastal or low lying areas in southern districts.

Objectives:

- to make easy availability of egg and meat in rural area
- to improve farmers nutritional and socio- economic status through duck rearing
- to make farmers economically benefited through duck rearing
- to create self employment opportunity in the locality

Methodology: To address the objective, six farmers were selected. Each farmer was given 10 ducks (Duck 09 + Drake 01). The farmers made their duck house (6ft X 3ft X 5ft) using tin, wood, straw, bamboo, and other available materials. The floor space for ducks was 1.5–2.0 square feet. Natural and supplementary feeding practice was followed for layer ducks. Duck farmers collected various feed ingredients (paddy, wheat bran, broken rice, rice polish etc.) and prepared a mixed feed in their farm premises. Each duck were given 200 g (rice polish, rice grain, snail & vitamin) feed/ day in early morning and evening during laying period. Ducks are started laying eggs from the age of 6 months, following a 'Four-Two-Four-Two' pattern (lay eggs for a four-month continuous period with a break for two months). Farmers collected eggs in the morning those were laid at night. For disease prevention, ducks were routinely vaccinated with Duck Plague and Fowl Cholera vaccines at three months interval.

Key findings: Through Jinding duck rearing, farmer able to produce the average monthly egg production was 137 nos. The average egg production cost was Tk. 734/family. The average monthly income from eggs was Tk. 2000/family. Farmers can earn a net profit amounting Tk. 970/month. In comparison to indigenous and Jinding duck (from within 10 nos.), average monthly gross incomes were Tk. 1056 and Tk. 2000, respectively. The results showed that average monthly income/farm family increased by 24% through farming of Jinding duck than indigenous duck.

Key words: Rearing, Jinding duck, Rural condition

12.5. Fisheries Component

12.5.1. Performance of Carp Polyculture of fish in Seasonal pond at five FSRD sites of BARI

Title: Performance of Carp Polyculture of fish in Seasonal pond

Background: Polyculture began in China more than 1000 years ago. The practice has spread throughout Southeast Asia, and into other parts of the world. Polyculture is the practice of producing more than one species of fish in the same pond. The motivating principle is that fish production in ponds may be maximized by raising a combination of species having different food habits. The concept of polyculture of fish is based on the concept of total utilization of different tropic and spatial niches of a pond in order to obtain maximum fish production per unit area (Ahmed and Alam, 1989). The compatible fish species having complimentary feeding habits are stocked so that all the ecological niches of pond ecosystem are effectively utilised. Depending on the compatibility and type of feeding habits of the fishes, the deferent types of fishes are accumulated in Polyculture system. Exotic species have been identified and recommended for culture in the composite fish culture technology. The most successful system of pond fish culture is the polyculture of three Indian major carp species - catla, rohu and mrigal along with three Chinese carps viz. silver carp, grass carp and common carp. The possibilities of increasing fish production per unit area are higher in polyculture compared to monoculture system. Different species combinations in polyculture systems are effectively contributed to improve the pond environment.

Objectives

i) To utilize unused or underutilized ponds by growing seasonal fish
ii) To increase income of the farmers
iii) To reduce malnutrition by eating fish from the mini ponds

Methodology: Improper management is the major hindrance against profitability of fish culture in pond under homestead area. The carp polyculture program in seasonal ponds were undertaken at the 5 FSRD sites of BARI with the objectives of increasing farmer's income and removing protein deficiency of rural people. For fish cultivation, weeds and wild fishes were removed from the pond and Lime was given at the rate of 1 kg per decimal as well as prepared for stocking with organic manure (cowdung) at the rate of 3 kg per decimal. Fingerlings stocking density is mostly depending on fingerlings size, species, pond depth, feed availability etc. However, in polyculture system, Silver carp, Catla, Rui, Mrigal, Common and Mirror carp may form 20–30%, 10–15%, 15–20%, 10–15% and 15–20% respectively maintaining 20-30 fingerlings decimal-1. Fish feed partially collected and supplied by the co-operative farmers whereas lime and fingerlings were supported from the program. Periodic checking and suggestion were given by the office personnel of the respective FSRD site.

Key findings

- From carp polyculture (Silver carp, Rajputi, Rui, Katla, Mrigel and Mirror carps) practices in seasonal ponds (9-16 decimal sized with 1.2 to 2 m depth) it was found that the survival rate of various fishes ranged from 64% to 91%.
- The total fish production was found 99, 142, 142, 188 and 95 kg pond^{-1} with gross margin of Tk. 10208, 13450, 17011, 13175 and 9750 pond^{-1} in Rangpur, Pabna, Faridpur, Tangail and Sherpur, respectively. It was observed that, farmers sold most of the portion of fish (Avg. 113 kg pond^{-1}) where, they consumed about Avg. 51 kg pond-1and distributed Avg. 12 kg pond^{-1} among their neighbours, relatives and well-wishers of the produced fish.

Key words: Carp polyculture, Fish, Gross margin, Seasonal pond.

12.5.2. Mixed fish cultivation on farmer's demonstration pond

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Mixed fish cultivation on farmer's demonstration pond

Background: Bangladesh is a country with thousands of rivers and ponds and is notable for being a fish-loving nation. Carp species are the most important fish species in Bangladesh, where more than 80 percent of aquaculture production is from inland ponds. The most farmed carp species are Rohu, Silver

carp, Mrigal and Shorputi. These fishes are commonly grown together (known as polyculture) and these multi species systems are highly productive. These four fishes are of great favorite to consumers because of its delicious taste and therefore they have a great demand and fetch high price in the market.

Objectives

i. To utilize unused or underutilized ponds by growing seasonal fish
ii. To increase income of the farmers
iii. To reduce malnutrition by eating fish from the mini ponds

Methodology: The program was initiated at the FSRD site, Tengra, Sreepur, Gazipur during 2018-20 to increase productivity of the existing ponds and also to increase farm income. Five farmer's ponds were selected for the mixed fish cultivation. The size of each pond was about 1 bigha (33 dec.). Ponds were primarily rain fed, well exposed to sunlight and without inlet or outlet but had facilities to provide water as and when needed from a deep tube-well using a flexible plastic pipe. Before releasing fingerlings, ponds were limed and unwanted fish species were removed. The ponds were fertilized with cow manure at the rate of 1,000 kg/ha. Four species of fish namely, rohu, silver carp, Mrigal and shorputi were supplied to the farmers' pond by maintaining the ration of 150 fish per decimal. Recommended management practices were followed for fish polyculture.

Key findings: Irrespective of fish species, initial average size and weight was 5.0 cm and 29.62 g respectively. The highest gained weight was found in Mrigal (761 g) followed by silver carp, rohu and the lowest was found in shorputi (414 g). The average highest gross margin per farmer was recorded in the year 2020-2021 (Tk. 272522 ha^{-1}) and the lowest gross margin was recorded in the year 2018-2019 (Tk.122000 ha^{-1}).

Key words: Fish, Net return, Production, Pond.

12.5. 3. Semi-aquatic production system of vegetables, fish and fruit in mini pond

FSRD site: Tengra, Sreepur, Gazipur (BRRI)

Title: Semi-aquatic production system of vegetables, fish and fruit in mini pond

Objectives

i. To utilize unused or underutilized ponds by growing seasonal fish and vegetables
ii. To increase income of the farmers
iii. To reduce malnutrition by eating fish from the mini ponds

Background: About 90% of the 14 million homesteads in Bangladesh have an average area of 810 square meters area. In many of these homestead areas, there is a pond and there is considerable fallow land around the homestead pond, which can be used for vegetables production. By establishing a mixed farming system, a marginal or poor family can grow enough vegetables and fish. In mixed farming system, different kinds of vegetables can be grown on the bank of a mini pond throughout the year and aroid can be grown in the pond along with fishes to meet the family nutritional requirements. The present study aimed to develop mixed farming system technology in mini pond for diversifying and maximizing yield.

Methodology: Semi-aquatic production system of vegetables, fish and fruit system was conducted during 2019-20 in three derelict ponds. BARI Panikachu-3 was transplanted during January. About 60 days after transplanting Monosex Telapia was supplied in the pond and released maintaining stocking density: 80 piece/dec. Rabi (Bottle gourd, sweet gourd, country bean and yard long bean) and kharif (Snake gourd, sponge gourd, bitter gourd and ash gourd) vegetables were cultivated in trellis on the dyke of the pond. Fruits (Papaya) were cultivated on the bank of the pond. Recommended management practices were followed for different crops. After about 60 days of transplanting, aroids started to give stolon and continued for 3 to 4 months. Aroids were harvested within seven months from planting.

Key findings: The highest vegetables yield in dyke was 239 and 281 kg during 2019 and 2020,

respectively. The highest yields of aroids were 150 and 1600 pieces during 2019 and 2020, respectively. The Maximum yield of stolon was 72 kg and 855 kg, respectively in the two successive years. The highest gross margin was obtained from the pond of Borhan Uddin Tk. 16660 and Tk. 60350, respectively during 2019 and 2020 and the lowest gross margin was found from the pond of Nurul Haque Tk. 3660 and Tk. 4550, respectively during 2019 and 2020.

Key words: Aroids, Stolon, Semi-aquatic, Fish, Gross margin

12.5. 4. Culture of Monosex GIFT (Oreochromis niloticus) with Shing (Heteropneustes fossilis) and Magur (Clarias batrachus) in farmer's pond

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

Title: Culture of Monosex GIFT (Oreochromis niloticus) with Shing (Heteropneustes fossilis) and Magur (Clarias batrachus) in farmer's pond

Background: Monosex GIFT strain (Oreochromis niloticus) is a popular aquaculture species in Bangladesh (Kohinoor, *et al.,* 2011). Commercially this high yielding fish species is being cultured throughout the country in different ecosystems. But in recent years, most of the farmers reported that they are not getting enough profit from tilapia culture. This is mainly due to high price of commercial pelleted fish feed and comparatively less price of tilapia in the market. Therefore, sometimes farmers are getting frustrated to continue tilapia culture in their farms. As such monosex GIFT strain with other commercial indigenous high valued fish species was under taken.

Objective: To know the results of polyculture of monosex GIFT strain with Magur and Shing and its economic benefit.

Methodology: Fingerlings of Monosex GIFT (*O. niloticus*), Shing (*H. fossilis*) and Magur (*C. batrachus*) were stocked in ponds at a stocking density of 25,000, 40,000, and 5,000 ha^{-1}, respectively. Supplementary feed (30% crude protein) were supplied to the fishes at the rate of 3-8% of body weight. At fortnightly interval fish sampling was done by measuring the weight of fish and to observe the health condition of fish. Lime and table salt (NaCl) were applied at the rate of 20 and 50 kg/acre at fortnightly intervals to the ponds.

Key findings:

- At harvest, the weights of monosex GIFT were 205 to 218 g.
- Harvesting weight of Shing reached 33-38g ±3.94g , while Magur were 122-135 g.
- Based on the number of fish harvested, survival ranged from 74-93%. Among the species, Shing showed the good survival and Magur performed less survival among the species.
- After six months rearing, the productions obtained were 13440 to 13638 kg.
- The contribution of Shing and Magur were 10.50% to the total production

Key words: Monosex GIFT, Shing and Magur

12.5.5. Polyculture of carps using over wintered fingerlings

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

Title: Polyculture of carps using over wintered fingerlings

Background: Over wintered fingerlings better for fish production. Low density of fingerling is required for profitable Polyculture of carps fishes (Alam, *et al.,* 2002). The lower stocking density, over wintered fingerlings and better management using fertilization and supplementary feed in optimum amounts are three key factors for obtaining higher production with individual large size fish in a shorter culture period.

Objectives:

i. To observe the performance wintered carp fingerlings in Polyculture system
ii. To increase income of farmer

Methodology: The technology was demonstrated in two farmers' ponds (1000 to 1600 m^2) during April to October 2018. Before stocking, rotenone was used at the rate of 12.5 kg/ha in two demonstration ponds to eradicate the all sorts of fish species. After 3 days of poisoning, ponds were filled up with underground water at the 1.5 meter depth and treated with lime at the rate of 250 kg^{-1} ha^{-1}. Five days after liming, ponds were fertilized with cow dung at the rate of 1,000 kg/ha. After pond preparation, fingerlings of Rohu (Labeo rohita), Catla (Catla Catla) and Mrigal (Cirhinus cirrhosus) were stocked in first week of April 2018 at a stocking density of 3,000 /ha, respectively at the ratio of 1:1:1. During stocking, the initial weight of Rohu, Catla, and Mrigal fish were 40.23±2.68, 55.23±2.48 and 37.35 ±2.49g, respectively. Feeding began immediately after stocking. Fishes were fed at a rate of 4-7% of body weight with rice bran (80%) and mustard oil cake (20%). Besides feeding, all the ponds were fertilized with organic fertilizer (Cowdung) at the rate of 1,000 kg/ha/15days interval. The ponds were sampled monthly by using a seine net for weighing fish of each species to measure the growth and to assess the health status as well as feed adjustment. After six months of rearing, all fishes were harvested through seine netting and pond drying. After harvesting, fishes were counted and weighed from each pond to assess the survival rate and production.

Key findings:

1. The average survival rate of fish was found to be varied between the 84-96%.
2. After six months of culture period, the average production was obtained 932 Kg.
3. The gross margin of Tk.75025

The production and gross margin can be increased through polyculture of carps with over wintered fingerlings. However, the lower stocking density, over wintered fingerlings and better management using fertilization and supplementary feed in optimum amounts are three key factors for obtaining higher production with individual large size fish in a shorter culture period.

Farmers' Reaction: Farmers are very happy to see the individual growth of carps. They are able to understand the advantage of overwinter fingerlings and lower stocking density of carps

Key words: Polyculture, Carps, Wintered and Fingerlings

12.5.6. Refinement of Culture technique of Pabda (Ompok pabda) & Gulsha (Mystus cavasius) with Rui (Labeo rohita) in farmers ponds

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Title: Refinement of Culture technique of Pabda (Ompok pabda) & Gulsha (Mystus cavasius) with Rui (Labeo rohita) in farmers ponds

Background: Pabda (Ompok pabda) and Gulsha (Mystus cavasius) are great favorite to consumers because of its delicious taste and have a great demand fetching high price in the market (Kohinoor, *et al.,* 2011) though these two species have been reported quite favourable under standard conditions of carp farming. This trial was designed to refine the production technique of Pabda (Ompok pabda) and Gulsha (Mystus cavasius) with carp at Mokamia, Fulpur, Mymensingh during May to September 2018 for the period of 6 months in two farmer's ponds.

Objectives:

1. To refine the production technique of Pabda (Ompok pabda) and Gulsha (Mystus cavasius) with carp at farmers pond
2. To increase income of farmer

Methodology: Two farmer's pond having 25 and 20 decimal were selected at FSRD site, Mokamia, Fulpur, Mymensinghfor conducting the trial in farmers ponds during May to September, 2018. Prior to stock, ponds were dried and cleaned for weed and unwanted aquatic animals. Then limed at the rate of 250 kg ha^{-1} were applied. Five days after liming, water supplied from shallow tube well to the ponds and filled up to the depth of 1 meter. Fingerlings of Pabda, Gulsha and Rui were stocked in April 2018 at a stocking density of 2.00, 0.75 and 0.0125 lac ha^{-1}, respectively. Following day after stocking supplementary feed (30% crude

protein) were applied at a rate of 3-8% of body weight. Fishes under the trial ponds were sampled regularly at fortnightly intervals to determine growth rate as well as feed adjustment. After six months of culture period, fish were harvested by repeated seine netting. Total bulk weight and number of fish from each pond were recorded. Survival and gross production of fish of each pond was estimated.

Key findings:

1. The average survival rate of fish was found to be varied between the 84-96%.
2. After six months rearing, the production obtained were 7381 kg ha^{-1}. The relative contribution of Pabda and Gulsha in total production was 88.55% while in case of Rui, the relative contribution was 11.67%.
3. Due to higher production, the gross margin also higher Tk.103175.

   In the present study, the production as well as gross return was very encouraging. The fish farmer would get opportunity to sell the high valued fish Pabda and Gulsha at a higher price in the market and they would also get an opportunity to consume the fish.

Key words: Refinement, Pabda (Ompok pabda), Gulsha (Mystus cavasius) and Rui (Labeo rohita)

12.5.7. Refinement of Mono sex GIFT Tilapia with Shing in ponds

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Title: Refinement of Mono sex GIFT Tilapia with Shing in ponds

Background: Monosex GIFT strain (Oreochromis niloticus) is a popular aquaculture species in Bangladesh. Commercially this high yielding fish species is being cultured throughout the country in different ecosystems. The present production of tilapia in Bangladesh is 3.77 lac MT in 2015-16 (FRSS, 2017). Last couple of years back, farmers obtained remarkable profit from monosex GIFT strain culture (Kohinoor *et al.,* 1999). But in recent years, most of the farmers reported that they are not getting enough profit from tilapia culture. This is mainly due to high price of commercial pelleted fish feed and comparatively less price of tilapia in the market. In Bangladesh, most of the farmers are growing tilapia in mono-culture management using pelleted supplementary feed with the stocking density of 50000 to 75000/ha. Under these circumstances, farmers are looking for alternative species to culture in their farms to maximize the production as well as profit. Among the available farmed species, GIFT tilapia & Shing are the suitable species for polyculture due to their desirable characteristics and high market price. In 2017, BFRI developed a culture technology of GIFT tilapia with Shing in ponds. So, proposed trial was undertaken to refine the production technique of GIFT tilapia at on-farm management.

Objectives:

1. To refine the production technique of Mono sex GIFT Tilapia with Shing in farmers ponds
2. To increase income of farmer

Methodology: This technology was demonstrated in two farmer's pond at FSRD Mokamia, Fulpur, Mymensinghduring April to August 2018. Prior to stocking, ponds were dried and cleaned for weed and unwanted aquatic animals. The dried ponds were left exposed to sunlight for several days and then limed at the rate of 250 kg/ha. Five days after liming, water was supplied from shallow tube well to the ponds and filled up to the depth of 1 meter. Fingerlings of monosex GIFT and Shing were stocked in April 2018 at a stocking density of 62500 and 50000/ha, respectively. The initial weights of monosex GIFT and Shing were 3.53±0.74 and 2.22±0.67g. Feeding began immediately after stocking. Fish were fed with floating feed (28% crude protein) at a rate of 4-8% of body weight. Fishes under the demonstration ponds were sampled regularly at fortnightly intervals to determine growth rate as well as feed adjustment. After five months of rearing, the fish were harvested. Primarily the harvesting of fish was performed by repeated netting using a seine net and final harvesting was done by dewatering the ponds with a submerged low lift pump. During harvest, all fishes were counted and weighed from each pond to assess the survival rate and production.

Key findings

- The average survival rate of monosex GIFT was 87% while the survival rate of Shing 71%
- The production of monosex GIFT and Shing was 14091 kg/ha and contribution of monosex GIFT in total production was 88.69% per pond
- Gross margin generated by Mono sex GIFT Tilapia with Shing over a period of four months Tk. 573332 ha $^{-1}$.

Farmer's Reaction

- Farmers are very satisfied with the growth and production of GIFT in their ponds
- They are interested to grow the fish for the next time in their ponds

Key words: Mono sex GIFT Tilapia, Shing and ponds

12.5.8. Culture of Pabda & Gulsha with carp in farmer's pond

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Title: Culture of Pabda & Gulsha with carp in farmer's pond

Background: Pabda (Ompok pabda) and Gulsha (Mystus cavasius) is very important and costly fish. These two fish species more or less extinct in the natural water body. Recently BFRI has developed culture technology of two fishes in confined pond. So this trail was designed to evaluate the production performances of pabda (Ompok pabda) and Gulsha (Mystus cavasius) with carp in the farmers pond during June to November 2019 for the period of 6 months in two farmer's ponds.

Objectives:

1. To evaluate the production performances of pabda (Ompok pabda) and Gulsha (Mystus cavasius) with carp in the farmers pond
2. To increase income and fulfill nutrition of farm family

Methodology: Two farmers pond were selected for this trial FSRD site, Mokamia, Fulpur, Mymensingh having area of 0.25 acre each. Before stocking of fingerlings, ponds were dried and bleaching powder and lime was applied to the ponds at the rate of 5.0 and 100 kg/acre. Five days after liming, ponds were filled up with water from shallow tube well upto 1.50 meter. After liming, urea and TSP were applied at the rate of 5.0 and 10.0 kg/acre, respectively. Three days after fertilization, fingerlings of Pabda, Gulsha, Silver Carp and Rui were stocked to the prepared ponds. Fingerlings of Pabda, Gulsha, Silver Carp and Rui were stocked in ponds at a stocking density of 1.0 lac, 0.75 lac, 0.005 lac and 0.005 lac/acre, respectively. Feeding began immediately after stocking. Fish were fed with supplementary feed (30% crude protein) at a rate of 3-7% of body weight. In all the ponds lime and table salt (NaCl) were applied at the rate of 50 and 125 kg/ha at fortnightly intervals.. After six months (July) of culture period, fish were harvested by repeated seine netting.

Key findings:

- After six months after rearing, the production were obtained 1036 kg per pond.
- The relative contribution of pabda and gulsha in total production was 74.25% while in case of Rui and Silver carp the relative contribution was 25.75%.
- The gross margin was Tk. 173642 per pond and (Tk. 1736245/ha). The fish farmer would get opportunity to sell the high valued fish Pabda and Gulsha at a higher price in the market and they would also get an opportunity to consume the fish.

Key words: Culture, Pabda. Gulsha and Carp

12.5.9. Polyculture of Carp with GIFT Tilapia and Shing

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Title: Polyculture of Carp with GIFT Tilapia and Shing

Background: The trial entitled Polyculture of Carp with GIFT and Shing were demonstrated in two farmers ponds at FSRD Site, Mokamia, Fulpur, Mymensingh during May to November 2019 for estimating the production carps with GIFT and Shing.

Objectives:

1. To observe the performance Polyculture of Carp with GIFT Tilapia and Shing in farmer's pond and
2. To increase income and fulfill nutrition of farm family

Methodology: Polyculture of Carp with GIFT and Shing were demonstrated in two farmers ponds during May to November 2019. The areas of the ponds were 30 and 20 decimal, respectively. Before stocking, rotenone have been used at the rate of 12.5 kg/ha in all the selected ponds to eradicate the all sorts of fish species. Then ponds have been treated with lime at the rate of 250 kg/ha. Five days after liming, ponds fertilized with cow dung (raw form) at the rate of 1,000 kg/ha. After the pond preparation, fingerlings of Rohu, (Labeo rohita), Catla, (Catla catla) and Mrigal (Cirhinus cirrhosus), GIFT (Oreochromis niloticus) and Shing (Heteropneustes fossilis) were stocked in first week of May 2019 at a stocking density of 1000, 1000, 1000, 2000 and 20000/acre, respectively. During stocking, the initial weight range of Rohu, Catla and Mrigal fish are 34-38, 40-48 and 30-37, respectively. While the initial weight of GIFT and Shing are 4.0 and 3.0g, respectively. Fish were fed at a rate of 3-6% of body weight with rice bran (80%) and mustard oil cake (20%). Besides feeding, all the ponds a fertilized with organic fertilizer (Cowdung) at the rate of 1,000 kg/ha/15 days interval. Fishes under the demonstration ponds were sampled regularly at monthly intervals to determine growth rate as well as feed adjustment. These fishes were returned into the ponds after sampling. After six months of culture period, fish were harvested by repeated seine netting. After seine netting, the pond water was pumped out and all fishes were harvested.

Key findings:

- After six months rearing, the total fish productions was obtained 746 kg /pond. The contribution of GIFT and Shing in total production was 4460 kg per pond.
- The cost of production was Tk. 72585 and gross margin Tk. 94060 was obtained from Polyculture of Carp with GIFT and Shing in a pond.
- The production and economic return of carps with GIFT tilapia and Shing in polyculture management was encouraging but culture of endangered species could ensure the availability as well as conservation of this species in inland waters.

Key words: Polyculture, Carp, GIFT Tilapia and Shing

12.5.10. Culture of Pabda with Magur and Carps

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

Title: Culture of Pabda with Magur and Carps

Background: This technology was demonstrated for the period of 6 months in two farmer's pond during June to December 2020. Prior to stocking, ponds were dried and cleaned for weed and unwanted aquatic animals. The dried ponds were left exposed to sunlight for several days and then limed at the rate of 250 kg/ha. Five days after liming, water were supplied from shallow tube well to the ponds and filled up to the depth of 1 meter.

Objectives:

1. To observe the performance of mixed culture pabda with magur and carps in farmer's pond and
2. To increase income and fulfill nutrition of farm family

Methodology: Fingerlings of carps (Rohu, Catla and Mrigal), Pabda and Magur were stocked in June 2020 at a stocking density of 7500, 250000 and 25000/ha, respectively. Feeding began immediately after stocking. Fish were fed at a rate of 3-6% of body weight with rice bran, mustard oil cake, wheat bran and

fish meal (28% crude protein). Besides feeding, all the ponds were fertilized with organic fertilizer (Cowdung) at the rate of 1,000 kg/ha/15 days interval. Fishes under the demonstration ponds were sampled regularly at monthly intervals to determine growth rate as well as feed adjustment. After six months of culture period, fish were harvested. Survival and gross production of fish of each pond was estimated.

Key findings:

- The survival rate of various species in pond was fairly high except Magur.
- The mean survival rate was 81.20±7.30. The survival rate of pabda and Magur was more or less same. After six months rearing, the production obtained 1327 kg per pond.

Key words: Culture, Pabda, Magur and Carps

12.5.11. Culture of Koi with GIFT Tilapia and Silver carp in farmer's pond

FSRD site: Mokamia, Fulpur, Mymensingh (BFRI)

Title: Culture of Koi with GIFT Tilapia and Silver carp in farmers pond

Background: This technology was demonstrated for the period of 5 months in two farmer's ponds during June to October 2020. Prior to stocking, ponds were dried and cleaned for weed and unwanted aquatic animals. The dried ponds were left exposed to sunlight for several days and then limed at the rate of 250 kg ha^{-1}. Five days after liming, water were supplied from shallow tube well to the ponds and filled up to the depth of 1 meter.

Objectives:

1. To observe the performance of mixed culture Koi with GIFT Tilapia and Silver carp in farmers pond
2. To increase income and fulfill nutrition of farm family

Methodology: This technology was demonstrated for the period of 5 months in two farmer's ponds during June to October 2020. Prior to stocking, ponds were dried and cleaned for weed and unwanted aquatic animals. The dried ponds were left exposed to sunlight for several days and then limed at the rate of 250 kg/ha. Five days after liming, water were supplied from shallow tube well to the ponds and filled up to the depth of 1 meter. Fingerlings of Koi, with Tilapia and Silver carp were stocked in June at a stocking density of 375000; 50000 and 1250/ha, respectively. Feeding began immediately after stocking. Fish were fed at a rate of 3-8% of body weight with floating supplementary feed (30% crude protein). Besides feeding, all the ponds were fertilized with lime at the rate of 50 kg/ha/15 days interval. Fishes under the demonstration ponds were sampled regularly at fortnightly intervals to determine growth rate as well as feed adjustment. After five months culture period, fish were harvested. Survival and gross production of fish of each pond was estimated.

Key findings:

- The survival rate of various species in ponds was fairly high. The main factor that may have attributed to the high survival was proper stocking of healthy seed stocked, freedom from predation favorable ecological conditions and proper feeding etc. In case of Koi, the survival rate was in 84.5%. However, overall mean survival rate was 88±6.
- After five months rearing, the production was obtained 2571 kg per pond. The yield of Koi was 2147 kg per pond. Among the species, individual contribution was comparatively highest in case of Koi (82-84%). The results of the study resembles with findings (Kohinoor, *et al.,* 2017).

Key words: Koi, GIFT Tilapia and Silver carp and pond

12.5.12. Culture of Shing with Magur in ponds

FSRD site: Mokamia, Fulpur, Mymensingh(BFRI)

Title: Culture of Shing with Magur in ponds

Background: The technology entitled Culture of Shing with Magur in ponds was demonstrated for the

period of 6 months in two farmer's ponds at FSRD Site Mokamia, Fulpur, Mymensingh during July to November 2020.

Objectives:

1. To observe the performance of mixed culture Shing with Magur in ponds in farmers pond
2. To increase income and fulfill nutrition of farm family

Methodology: The area of the ponds were 0.30 and 0.20 acre, respectively. Prior to stock, ponds were dried and cleaned for weed and unwanted aquatic animals. The dried ponds were left exposed to sunlight for several days and then limed at the rate of 250 kg/ha. Five days after liming, water were supplied from shallow tube well to the ponds and filled up to the depth of 1 meter. Fingerlings of Shing (Heteropneustes fossilis) with Magur (Calarias batrachus) were stocked in ponds at a stocking density of 500000 & 25000 ha^{-1}, respectively. Feeding began immediately after stocking. Fish were fed with supplementary feed (30% crude protein) at a rate of 3-8% of body weight. All fish were harvested through pond drying after six months of rearing.

Key findings:

- The survival rates of Shing and Magur was fairly high. The average survival of Shing and Magur was 79% and 70% respectively.
- The harvesting weight of Shing and Magur were 45±7.8 and 162±18g. It was observed that harvesting weights of Magur was higher than Shing. The production of Shing and Magur was 2100 kg $pond^{-1}$. The contribution of Shing in total production was 86.74%.

Key words: Shing (Heteropneustes fossilis), Magur (Calarias batrachus), Survival, Fingerling and Stock

12.6. Off-farm component

12. 6.1. Additional income from off-farm activities at different FSRD Sites of BARI

Title: Additional income from off-farm activities

Background: Off-farm (non-farm) income refers to the portion of farm household income obtained off the farm, including nonfarm wages and salaries, pensions, and interest income earned by farm families. Since the last three decades or so, there has been increasing evidence showing that small-holder farm households in developing countries rarely rely on agriculture alone, but often maintain a portfolio of income activities in which off-farm activities are an important component.

Objectives

- To utilize properly the unused labor of women and men,
- To increase income of the farmers,
- To create employment and women empowerment.

Methodology: The off-farm activity was conducted at different FSRD sites during the years of 2018 to 2020. A sewing machine was supplied to train up the local women on cloth sewing. Some farm families' especially the women were engaged with off-farm activities. The women were engaged in making Kumra bora, Pilo cover, making handicrafts with rope, plastic ball etc. during their leisure periods and men were engaged with basket making and van/rickshaw pulling. Some farmers had small grocery shop and opened at his off-time and also had practice of weaving Katha and cloth sewing with machine. Commercially cooking is also practiced in some cases by the men.

Key findings: Off-farm activities with handicrafts, Kumra bora, cloth sewing, kantha sewing etc. has created positive impact among the farmers. It was found that after intervention the avg. net return increased 89%, with the avg. net return of Tk. 6226 per year. So, if all households could introduce some off-farm activities, it would be helpful to increase total farm income.

Key words: Labor, Net returns, Off-farm activities, Women Empowerment

12.6.2. Empowerment of Rural woman through off-farm activities

FSRD Site: Sreepur, Gazipur (BRRI)

Title: Empowerment of Rural woman through off-farm activities

Background: Many households are devastated by poverty and unemployment in Bangladesh. Women, especially those who are the heads of their households, are often among the poorest of the poor in Bangladesh. Women have few opportunities to earn income and are often discriminated against in the workforce. A small amount of money and proper tools can help these women start a small business and help them survive on a monthly basis. Bangladesh has a large textile industry and stitching garments is one job that is still valued and needed in Bangladesh. By providing women in need with sewing machines and training we can empower them to support themselves.

Objectives

- To increase income of the farmers,
- To create employment and women empowerment.

Methodology: The activity was conducted at the FSRD site Tengra, Sreepur, Gazipur during 2019-2020. Three sewing machines were supplied to the selected economically poor women farmers at the FSRD site. Base line information of the cooperative women farmers were recorded regarding their income and livelihood status. Using sewing machine, they made dresses and other materials that ordered by the villagers. Data regarding the income from sewing machine, their changes in livelihood status and their role in decision making were collected.

Key findings: After intervention net return and sale value was increased over before intervention during 2020. The average sale value was Tk. 32700 and net return was about Tk. 19400 woman farmer^{-1} during 2020.

Key words: Off-farm, Woman, Net return, Income.

B. Implementation status

1. Procurement

Table B.1.1. Procurement of equipment and capital items of BARC component

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
Furniture	17	148000	17	140600.00	
Computer and accessories	7	335000	7	271300.00	

Table B.1.2. Procurement of equipment and capital items of BARI component

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment	GD1				
1. Laptop Computer	3	180000	3	180000	
2. Desktop Computer	3	180000	3	180000	
3. Laser Printer	3	60000	3	60000	100%
4. UPS	3	30000	3	30000	
5. Scanner	3	30000	3	30000	

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(b) Field equipment	GD2				
1. Digital Camera and accessories	3	75000	3	75000	100%
2. Bicycle	5	75000	5	75000	

Table B.1.3. Procurement of equipment and capital items of BRRI component

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
a) Furniture	11	1,30,000	11	1,30,000	-
b) Equipment, Tools, etc.	07	2,27,200	07	2,26,900	-
c) Small Transport (Two-wheeler): Motor cycle	01	1,70,000	01	1,70,000	-

Table B.1.4. Procurement of equipment and capital items of BFRI component

Description of equipment & capital items	PP target		Achievements		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
Laptop computer with printer	01	60000	01	60000	
Digital camera	01	25000	01	25000	
IPS	01	40000	01	40000	
(b) Lab &field equipment					
Water Testing Kit	01	150000	01	150000	
(c) Other capital items					
Motor Cycle	01	175000	01	175000	

2. Establishment/renovation facilities

Table B .2.Establishment/renovation facilities: Not applicable.

Description of facilities	Newly established		U graded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

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

Table B.3. Training/study tour/ seminar/workshop/conference organized

Component	Description	Number of participants			Duration (Days)	Remarks
		Male	Female	Total		
BARC	Training	55	5	60	6	
	Workshop	164	20	184	3	
	Meeting	32	4	36	3	
BARI	Training	260	100	360	01	12 batches completed
	Workshop	40	20	60	01	One workshop completed.
	Others (Field day)	1500	500	2000	01	
BRRI	Training	116	64	180	01 (Each training)	Six batch , 30 participant per batch
BFRI	Training	21	19	40	04	

C. Financial and physical progress

Table C.1. Combined Financial and physical progress

Figure in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	10389564	9170169	9170169	00	100	
b. Field research/lab expenses and supplies	12621552	12410533	12410533	00	100	
c. Operating expenses	3177687	2963771	2963771	00	100	
d. Vehicle hire and fuel, oil and maintenance	1842834	1402491	1402491	00	100	
e. Training/workshop/seminar etc.	3037510	2957510	2957510	00	100	
f. Publications and printing	1124105	883505	883505	00	100	
g. Miscellaneous	651948	631297	631297	00	100	
h. Capital expenses	2018800	2018100	2018100	00	100	
Total	34864000	32437376	32437376	00	100	

Table C.2. Financial and physical progress of BARC Component

Figure in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	2451697	2451697	2451697	00	100	
b. Field research/lab expenses and supplies	197873	197873	197873	00	100	
c. Operating expenses	599584	599583.5	599583.5	00	100	
d. Vehicle hire and fuel, oil and maintenance	108354	108354	108354	00	100	
e. Training/workshop/seminar etc.	1406510	1406510	1406510	00	100	

Figure in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
f. Publications and printing	774105	771705	771705	00	100	
g. Miscellaneous	199977	191212	191212	00	100	
h. Capital expenses	411900	411900	411900	00	100	
Total	6150000	6138835	6138835	00	100	

Table C.3. Financial and physical progressof BARI Component:

Figure in Tk.

Items of expenditure/activities	**Total approved budget**	**Fund received**	**Actual expenditure**	**Balance/ unspent**	**Physical progress (%)**	**Reasons for deviation**
a. Contractual staff salary	4129687	4129687	4129687	00	100	
b. Field research/lab expenses and supplies	5190681	5190681	5190681	00	100	
c. Operating expenses	1832276	1832276	1832276	00	100	
d. Vehicle hire and fuel, oil and maintenance	1018456	1018456	1018456	00	100	
e.Training/workshop/seminar etc.	981000	981000	981000	00	100	
f. Publications and printing	0	0	0	00	100	
g. Miscellaneous	231900	231900	231900	00	100	
h. Capital expenses	630000	630000	630000	00	100	
Total	**14014000**	**14014000**	**14014000**	**00**	**100**	

Table C.4. Financial and physical progressof BRRI Component:

Figure in Tk.

Items of expenditure/activities	**Total approved budget**	**Fund Received**	**Actual expenditure**	**Balance/ unspent**	**Physical progress**	**Reason for deviation**
a. Contractual staff salary	1636730	1636730	1636730	0.00	100	
b. Field research/lab expenses and supplies	2305408	2269182	2269182	0.00	100	
c. Operating expenses	379867	379036	379036	0.00	100	
d. Vehicle hire and fuel, oil and maintenance	206024	188969	188969	0.00	100	
e.Training/workshop/seminar etc.	500000	420000	420000	0.00	100	
f. Publications and printing	300000	88050	88050	0.00	100	
g. Miscellaneous	145071	144975	144975	0.00	100	
h. Capital expenses	526900	526900	526900	0.00	100	
Total	**6000000**	**5653842**	**5653842**	**0.00**	**100**	

Table C.5. Financial and physical progressof BFRI Component:

Figure in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual Expenditure	Balance/ unspent	Physical progress (%)	Reason for deviation
a. Contractual staff salary	2171450	952055	952055	0.00	100	
b. Field research/lab expenses and supplies	4927590	4752797	4752797	0.00	100	
c. Operating expenses	365960	152875	152875	0.00	100	
d. Vehicle hire and fuel, oil and maintenance	510000	86712	86712	0.00	100	
e. Training/workshop/seminar etc.	150000	150000	150000	0.00	100	
f. Publications and printing	50000	23750	23750	0.00	100	
g. Miscellaneous	75000	63210	63210	0.00	100	
h. Capital expenses	450000	449300	449300	0.00	100	
Total	**8700000**	**6630699**	**6630699**	**0.00**	**100**	

D. Achievement of Sub-project by objectives (Tangible form): Technology generated/developed

Table D.1. Achievement of Sub-project by objectives (Tangible form): Technology generated/developed by BARI Component

General/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) General objective: To improve livelihood of rural households through generation and adoption of Farming System Technologies.	**Modified vegetable production model development.** 1. Modified Syedpur Model for FSRD site Ajoddhapur, Rangpur. 2. Modified Ishan Gopalpur model for FSRD site Sholakundu, Faridpur.	Vegetables production increased by 282-306% compared to pre-intervention status	Maximum utilization of homestead area for safe and nutritious vegetables production.
b) Specific objective: i) To develop integrated farming technologies to maximize farm productivity with efficient use of farm resources.	Cropping patterns development using farm resources judiciously (7) CP1: T. Aus-T. Aman-Potato/Sweet gourd CP2: Lentil-Sesame-T. Aman CP3: Lentil-Jute-T. Aman CP4: Mustard-Jute-T. Aman CP5: Okra -T. Aman-Cabbage CP6: T. Aman -Potato-Mung bean-T. Aus CP7: T. Aus - T. Aman-Motor shuti-Boro	Rice equivalent yield increased in developed cropping pattern compared to existing pattern as follows- CP1: 78%. CP2: 30%. CP3: 27%. CP4: 24%. CP5: 20%. CP6: 213%. CP7: 185%.	Cropping intensity and productivity increased to a satisfactory level.

Table D.2. Achievement of Sub-project by objectives (Tangible form): Technology generated/developed by BRRI Component:

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)
i) To generate climate resilient and site specific farming system technologies by optimizing land use for the Madhupur Tract of Bangladesh	An improve cropping pattern for highland in Madhupur track soil: Mustard-Mungbean-T. Aus-Blackgram	Improved cropping pattern were tested where 196% and 385% higher rice equivalent yield (REY) and gross margin was found than the existing cropping pattern.	Income of farmers could be raised

Table D.3. Achievement of Sub-project by objectives (Tangible form): Technology generated/developed by BFRI Component:

General/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)
To develop location-specific system-based technologies	Intensive culture of Shing Culture of GIFT with Shing and Magur	Farmers are able to practice the improved technologies of fish culture in their pond	Fish production will be increased through using these technologies
To modify/fine tune on-station technologies generated by NARS institutes at different Agro-ecological Zones (AEZs)	Culture of Pabda & Gulsha with carp in farmer's pond Culture of GIFT with Shing and Magur in farmers pond Culture of Shing with GIFT Tilapia & carp in Farmer's pond	Farmers are able to grow out high valued fish, Pabda and Gulsha in polyculture management.	Pabda and Gulsha are endangered fish species. The production of these species will be increased by adopting this technology.
To integrate component technologies (crops, livestock, fisheries and homestead, etc.) for improving farm practices & establish linkage with different stakeholders	Year round vegetables production in homestead area Yield performance of Cucumber productions at farmers field Cultivation of HYV of Aus in rice field Integrated rice- fish culture in paddy fields	The production of vegetables was increased up to 85.77%. Gross margin was increased. Production cost reduced since less quantity of pesticides were applied. Family income was increased two to three times	Living standard of the farmer will be improved. Environmental pollution will be reduced. Farmers will be interested to grow vegetables (summer tomato & ladies finger) instead of rice cultivation at field.

General/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)
	Rearing of Sonali Chicken in farmers managed condition Production programme of improved breed of Duck (Jinding) Vaccination of cattle and goat in the selected farmer	Increased poultery birds production as well as family income	No. of duck & Chicken rearing farmers will be increased Pigeon farming will be disseminated Sonali chicken rearing will be increased than indigenous chicken rearing Jinding duck rearing will be increased than indigenous duck rearing. Application of anthelmintics to livestock animals will be increased Vaccination program will be spreading out

E: Information/knowledge generated/policy generated

Table E.1. Information/knowledge generated/policy generated by BARI Component

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
ii) To modify fine tune on station technologies generated by NARS institutes and at different FSRD sites of plainland ecosystems.	Year-round vegetables and fruits production in homestead area	**Vegetables:** Consumption, distribution and selling of vegetables and gross margin were increased about 388%, 106%, 104% and 376% respectively. **Fruits:** Consumption, distribution and selling of vegetables and gross margin were increased about 83%, 93%, 76% and 107%, respectively.	Income and family nutrition of farmers could be raised
	Production program with different varieties of Mustard, Potato, Tomato and Barley	The following varieties were identified as suitable for the tested location- BARI Sarisha-14, BARI Sarisha-17, BARI Sarisha-18,	Modern and high yielding crops varieties have been expanded.

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
		BARI Alu-25, BARI Alu-40, BARI Alu-41, BARI Alu-53, BARI Tomato-15, BARI Tomato-18, BARI Barley-7.	
	Improvement of the T. Aman-Mustard-Boro-cropping pattern through inclusion/improvement of Mustard variety.	Improved patterns (3) were tested and 21-82% higher REY was obtained compared to existing cropping pattern.	
	Spraying of Mango and other fruit trees	About 611 numbers of different types of fruit trees were sprayed.	Income and fruits production could be raised
	Establishment of homestead and nearby homestead fruit garden	About 3811 numbers of different fruit saplings were supplied.	Income and family nutrition of farmers could be raised
	Vaccination program of cattle, goat, sheep, chicken, duck and pigeon.	Significantly reduced disease incidence & mortality rate	Survival rate and production of cattle, goat, chicken, duck and pigeon have been increased
	Improvement of dairy cattle health by deworming and vitamin ADE injection.	Cattle body weight gain (70-100 g $day^{-1}animal^{-1}$), milk production (1.8 L day^{-1}) and lactation period (195 day) was increased by deworming and vitamin ADE injection.	Cattle health and production have been improved
	Cattle fattening program at farmers' level.	Cattle body weight and market value (28-65%) was increased.	Profitable cattle fattening system have been practiced.
	Calf rearing at farmers level	Body weight of calf under the program, increased (99%) rapidly.	Improved calf rearing system have been practiced.
	Goat rearing at farmer's household	The average gross margin was obtained Tk. 2033 $goat^{-1}$.	Goat rearing system has been practiced.
	Rearing of Sonali chicken at Farmers' household	Ranges of gross margin were Tk. 4151-10349	Income and family nutrition of farmers

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
		household^{-1}.	could be raised
	Rearing of Naked neck (Garchila) chicken at Farmers' household	The average gross margin was Tk. 5538 household^{-1}.	Income and family nutrition of farmers could be raised
	Duck rearing at farmer's household	Monthly income ranges from Tk. 1100-2400 household^{-1}	Income and family nutrition of farmers could be raised
	Turkey rearing under semi scavenging system at farmers' household	The average gross margin was Tk. 6700 household^{-1}.	Income and family nutrition of farmers could be raised
	Pigeon rearing at farmer's household	Income ranges from Tk. 1250-5300 household^{-1}	Income and family nutrition of farmers could be raised
	Farm Yard Manure (FYM) production at farmer's household	About 3050 kg FYM produced per household per year	Soil health and crop productivity could be improved
	Vermicompost production at farmer's household	About 320 kg vermicompost produced per household per year	Soil health and crop productivity could be improved
	Green fodder production at farmer's household	About 53 t ha^{-1} Napier grass produced per household per year	Green fodder for cattle could be available
	Maximization of farmer's income through carp polyculture technique at low cost management in seasonal pond	Range of gross margin was 8000- Tk. 17133 pond^{-1}	Income and family nutrition of farmers could be raised
	Income enhancement through off-farm activities	The average gross margin was increased 96%.	Income of farmer especially women farmer could be raised
iii) To integrate component technologies (crops, livestock, fisheries, agro-forestry and homestead gardening, etc.) for improving farm productivity.	Direct and indirect integration among different farm components.	1. Compost pit-based integration. 2. Pond based integration. 3. Crop-Livestock integration 4. Crop-Livestock-Fisheries-Human integration	Sustainable farming system could be established
iv) To establish linkage with different	Local Service Provider (LSP), Field day,	One male and one female LSP developed.	Linkage improved among the

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
stakeholders.	development, Media program	Field day and media helped to disseminate home garden and field crops technologies.	Researcher-Extensionist-Farmers-Media

Table E.2. Information/knowledge generated/policy generated by BRRI Component

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
ii) To fine tune and disseminate farming system technologies in the physical, biological and social environment of the extrapolation domain with efficient use of farm resources	Performance of turmeric and ginger production under fruit base agro forestry system	Turmeric and ginger were tested under fruit base agro forestry system. Average gross margin Tk. 6,00,000 ha^{-1} and Tk. 3,13,000 ha^{-1} was obtained from ginger and turmeric respectively	Income of farmers could be raised
	Improvement of the existing Boro-Fallow-T. Aman cropping pattern through inclusion of oil seed and pulse crops	Improved patterns (2) were tested and 219-367% higher gross margin was found than the existing cropping pattern. About 77-78% REY was increased in improved cropping pattern	Income of farmers could be raised
	Mass vaccination of cattle, goat, chicken, duck and pigeon	Significantly reduced mortality rate	Survival rate of cattle, goat, chicken, duck and pigeon could be increased
	Small scale pigeon rearing in farmer's household	20% consumption and income increased Tk. 2167 per farmer.	Income and family nutrition of farmers may be raised
	Maximization of farmer's income through carp polyculture technique at low cost management in perennial pond	Range of gross margin was Tk. 1,22,000- 2,72,522 ha^{-1}	Income and family nutrition of farmers could be raised

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
	Semi-aquatic production system of vegetables, fish and fruit in mini pond	Range of gross margin was Tk. 3,660-60,350 per farmer and benefit cost ratio (BCR) range 1.33- 5.12	Income and family nutrition of farmers could be raised
	Spraying of mango & jack fruit trees at FSRD site, Sreepur, Gazipur	44-50% higher production of jackfruit and mango was found	Income and family nutrition of farmers could be raised
	Empowerment of Rural woman through off-farm activities at FSRD site, Sreepur, Gazipur	676% higher income was found	Income of women farmer could be raised
	Turkey rearing under scavenging system	Ranges of gross margin was Tk. 1,41,550-3,50,45 per household	Income and family nutrition of farmers could be raised
	Rearing of Sonali chicken at Farmers' household	Range of gross margin was Tk. 49,300-67,500 per household	Income and family nutrition of farmers could be raised
	Year round vegetables production in homestead	Consumption, distribution and selling of vegetables increased about 92%, 89% and 85% respectively. Average gross margin was Tk. 4,882 per farmer	Income and family nutrition of farmers could be raised
	Performance of chewing type sugarcane cultivation in homestead	Gross margin per pit was ranged 528- Tk. 900 year^{-1}	Income and family nutrition of farmers could be raised
	Production program of modern Aus rice varieties	Average gross margin was ranged 29,600- Tk. 46,280 ha^{-1}.	Rice production and farmers income could be raised
	Production program of modern Aman rice	Average gross margin was ranged 21,800- Tk. 30,480	Rice production and farmers

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
	varieties	ha^{-1}.	income could be raised
	Production program of modern Boro rice varieties	Average gross margin was ranged 46,800- Tk. 56,850 ha^{-1}.	Rice production and farmers income could be raised

Table E.3. Information/knowledge generated/policy generated by BFRI Component

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
To develop location-specific system-based technologies To modify/fine tune on-station technologies generated by NARS institutes at different Agro-ecological Zones (AEZs)	Pabda & Gulsha stocked in pond at the stocking density of 250000 and 25000/ha GIFT, Shing and Magur stocked at 62500, 50000 and 12500/ha, respectively.	In Pabda & Gulsha Culture, average production of 7382 kg/ha/5. The average fish production of monosex culture was found to be 14263 kg/ha after five months rearing. The calculated average production of Pabda and Gulsha in polyculture management was 10372 kg/ha/6months.	Income of farmers could be raised
	The short duration vegetables like Tomato, Cabbage, Radish, Red amaranth, Indian spinach, Spinach, Lady's finger, etc. were produced in the beds and different vine types vegetable like Sweet Gourd, Biter Gourd, Wax Gourd, Bottle Gourd, Yard Long bean etc. were cultivated.	Homestead vegetable production gave a total yield of 2537.75 kg In another demonstration trial, hybrid Papaya (var. Red lady) produced an average yield of 750 kg Summer Tomato gave an average yield of 360 kg/farmer After Boro paddy, Binadhan-19 was introduced in the area. Average Aus rice production 7.76 tones/acre	

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
	Rearing of Duck in rural condition, Rearing of Pigeon in female management, Improvement of health condition of cattle through de-worming and Vaccination of Cattle, Goat, Chicken and Duck were carried out.	Average monthly egg production/farm family from duck was 150. Rearing of Pigeons a farmer averagely obtained 9 pairs of squabs which provided an amount of Tk. 3240/7 months. After de -worming, the body weight gain of treated cattle was 13% higher while in case of non treated cattle showed only 2.38%.	

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

Table: F.1. Materials Development/Publication made under the Sub-project by BARC Component

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Video ducmentation		1	Video ducmentation

Table: F.2. Materials Development/Publication made under the Sub-project by BARI Component

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
FSRD site, Ajoddhapur, Rangpur			
TV program		02	TV: Channel i and BTV
Documentary		01	Documentary: Success story of Anisa Begum

FSRD Site, Ganggarampur, Pabna

Publication	Number of publications		Remarks (e.g., paper title, name of journal, Conference name, etc.)
	Underpreparation	Completed and published	
Leaflet	-	01	Improvement of Mustard-Boro-T.Aman cropping pattern through inclusion of HYV

Journal publication	01	-	Screening of shade tolerant crops under Mango-based agroforestry system. Bangladesh J. Agril. Res.
Video clip TVprogram	 01	02	1. Livestock rearing 2. Fruit tree management Whole FSRD activities

FSRD Site, Sholakundu, Faridpur

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
TV program		03	1. BTV program on whole activities 2. Production program on summer tomato and bottle gourd 3. Intercropping of sugarcane andonion bulbp production activities
Video clip		3	1. Farming system research and development activates (Chui zal) 2. Distribution of fruit saplings 3. Vaccination activities
Newspaper		07	1.Livelihood improvement 2. Vaccination and deworming Program 3. BARI Shorisha-18 4. Summer vegetable Seed distribution 5. Fruit sapling distribution 6. Nutritious food to prevent corona 7. Nutritional security for preventing corona

FSRD Site, Atia, Tangail

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Journal publication	3 paper	-	On-farm evaluation and system efficiency of Boro-T. Aman-Mustard cropping pattern in Tangail. Bangladesh Journal of Agricultural Research On-farm evaluation and increasing productivity through Okra-Boro-T. Aman rice cropping pattern in Bangladesh. SAARC Journal of Agriculture Production of homestead vegetable a means of improving livelihood for resource poor household in Bangladesh. BJAR (Reviewed)

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Video clip		2	1. Field day on BARI Sarisha-17 2. Training and field day on BARI Kheshari-3
News Paper		01	Field day on BARI Sarisha-14 and 17, News paper "MojlomerKantha", dated-21.01.2021

FSRD Site, Tarakandi, Sherpur

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet flyeretc.	1	-	Cropping pattern development
Video clip/TV program	-	4	Homestead production, Duck rearing, Naked neck rearing and Pigeon
News Paper/Popular Article	-	1	

Table: F.3. Materials Development/Publication made under the Sub-project by BRRI Component

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Booklet		01	১. মধুপুর গড় কৃষি পরিবেশ অঞ্চলের জন্য উন্নত শস্য বিন্যাস প্রযুক্তি
		02	
Leaflet			১. অব্যবহৃত পুকুরে পানিকচু+মাছ এবং পাড়ে সবজি ও ফলের সমন্বিত চাষ: একটি লাভজনক পদ্ধতি ২. কৃষক পর্যায়ে বসতবাড়ীতে টার্কি পালন
Technology bulletin		01	১. মধুপুর গড় অঞ্চলের উঁচু জমির উপযোগী একটি উন্নত শস্য বিন্যাস: সরিষা-মুগডাল-রোপা আউশ-মাস-
Journal publication	01	-	Title: Productivity and nutritional values of integrated vegetable-fish farming from semi-aquatic systems Target Journal: Agronomy for sustainable development

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Video clip	-	02	1. Integrated farming system activities at the FSRD site Tengra, Sreepur, Gazipur. 2. Semi aquatic production system in mini pond at the FSRD site Tengra, Sreepur, Gazipur.

Table: F.4. Materials Development/Publication made under the Sub-project by BFRI Component

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.		Leaflet published	
TV program		1	Mati-O-manush

G. Description of generated Technology/Knowledge/Policy:

i. Technology Fact Sheet

Fact sheet-1

Title of the technology: Potato/Sweet gourd-T. Aus- T. Aman: A profitable four Crops based Cropping Pattern under AEZ-3

Introduction: The productivity is relatively low under existing practices. The productivity can be increased by inclusion of high value crops in the existing system. Potato-Boro-T. Aman rice cropping pattern is practiced in a vast area of Rangpur district. During Boro season farmers are totally dependent on underground water. Uplifting of underground water results increased cost of production that ultimately reduces the profit. For increasing productivity, development of alternate cropping pattern felt an urgent need. Further, vegetables production in this area is very low due to use of low yielding cultivar. In this context, new cropping pattern, Potato/Sweet gourd-T. Aus-T. Aman rice is developed with diverse crop combination where two rice, one tuber crop and one vegetables crop are included.

Description: Two upland crops i.e., Potato and Sweet gourd and two wetland crops i.e., T. Aus and T. Aman rice are included in this four crops-based cropping pattern. In case of upland crop, dry land preparation is required where lands are prepared at the joe condition of the soil by breaking soil clods and leveling field. Seeds are sown in line at field capacity of soil. For T. Aus and T. Aman rice, wet land preparation is required. Here, stagnant water is accumulated either from rainfall or irrigation sources and soil is puddled and rice seedlings are transplanted. In this cropping pattern, four crops are cultivated in sequence starting from early Rabi season with Potato, relaying with Sweet gourd followed by T. Aus and T. Aman. The main field duration of the Potato, Sweet gourd, T. Aus and T. Aman are about 72-75 days, Potato duration 60-65 days, 89-91 days and 97-99 days, respectively. So careful attention is given to timely establishment of crops. Sometimes rainfall delays the establishment of next crop especially upland crops. The cropping pattern-based fertilizer dose is considered (BARC, 2018) rather individual crop base. Micronutrient fertilizers are applied once in a year. The rice crop residue remains 20 cm and incorporate into the soil, which can add a considerable amount of different nutrients. Residual effect of P, K and micronutrients become available for succeeding crops considered during fertilizer dose determination. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation may be applied to prepare land at field capacity. Intercultural operations were done when necessary.

Cultivation procedure of Potato: Land is prepared by power tiller for Potato. If the soil is moist, then it needs to make some furrow on the land and wait two to three days for coming the joe condition. Land is prepared well, and Potato tuber is line sown in the ridge maintaining 60 cm × 25 cm spacing at field capacity of soil moisture at around mid to late November. All the fertilizers are applied as basal fertilizer except half of the urea which is applied as top dress at 30 days after planting followed by earthing up. Fertilizers are applied @ 135-25-140-17-3-1.5 kg ha^{-1} of N-P-K-S-Zn-B, respectively. The Potato variety is BARI Alu-25. One or two irrigations are required and are applied as and when necessary. Crop protection measures are taken if Potato is infested by pest and diseases. Haulm pulling needs to done before one week of Potato harvest. Potato tuber is harvested within first to second week of February.

Cultivation procedure of Sweet gourd: Sweet gourd seed is sown as relay with Potato and needs to sow one week after of Potato planting. Sweet gourd seed is sown on the Potato ridge maintaining the spacing 1.8 cm × 1.8 cm. No extra fertilizer is used for Sweet gourd and it can grow using the residual fertilizer of Potato. For this crop, no need of land preparation also. It uses the irrigation water that is provided for Potato. However, just after the harvest of Potato, one irrigation is need for Sweet gourd for quick growth. Seed rate is required 5 kg ha^{-1} and need to sow on last week of November to 1st week of December. The suitable Sweet gourd variety is BARI Hybrid Misti Kumra-1.Weeding and irrigation is needed during flowering and mid fruiting stage. Fruits of Sweet gourd can be harvested at early April to May.

Cultivation procedure of T. Aus rice: About two weeks after of harvesting the Sweet gourd, land is

irrigated and prepared by puddling with power tiller for T. Aus transplanting. At final land preparation 1/3 of urea and other fertilizers are applied as basal. Rest of 2/3 urea is applied as top dress two times at about 15 and 30 days after transplanting. Fertilizers are applied @ 97-20-40-13-3.5kg ha^{-1} of N-P-K-S-Zn, respectively. Twenty to twenty-five days old seedlings of T. Aus is transplanted in the middle of May. If necessary, irrigation is applied in the first month of transplanting. When rainy season starts the crop is usually grown as rainfed. Two times hand weeding is done following the urea top dressing. T. Aus variety is BRRI dhan48. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. One third of the urea is top dressed at 15 and 25 days after transplanting. Top dress is followed by weeding. Usually, irrigation is not necessary. However, if needed a light irrigation may be applied as and when necessary. Crop protection measures are taken if Aus is infested by pest and diseases. Special care may be needed to protect rice crop during maturity stage from bird, if the rice block is sporadic. T. Aus rice is harvested during 1st week to middle of August.

Cultivation procedure of T. Aman: About one week after of harvesting the T. Aus rice, land is irrigated and puddled by power tiller for T. Aman transplanting at 2nd week of August. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 number per hill. T. Aman variety is Binadhan-17. Fertilizers are applied @ 100-12-30-10-1.5kg ha^{-1} of N-P-K-S-Zn. All P, K, S, and Zn fertilizers are applied as basal. N are applied in 3 equal splits, the 1^{st} one as immediately after seedling establishment, the 2^{nd} one at early tillering stage and 3^{rd} one at 5-7 days before panicle initiation. Twenty-three to twenty-five days old seedlings of T. Aman rice are transplanted. Irrigation is applied as and when necessary. Two times hand weeding is done following the urea top dressing. Top dress is followed by weeding. Crop protection measures are taken if it is infested by pest and diseases T. Aman rice is harvested in the third week of November.

Suitable location/ecosystem: The technology is suitable for medium highland to highland of AEZ-3 with irrigation facilities. The four crops-based cropping patterns can be practiced in clay loam to sandy loam soil. The technology can also be followed in the other medium high lands to highlands in pocket areas if irrigation facilities exist.

Benefits: Rice equivalent yield of the improved cropping pattern is 51.39 t ha^{-1}. The gross margin (Tk. 403064 ha^{-1}) is 277% higher than the existing Potato-Boro-T. Aman cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 8.31.

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Fact sheet-2

Title of the technology : Improvement of existing cropping pattern T. Aman-Mustard-Boro through inclusion of suitable varieties in High Ganges River Floodplain (AEZ-11)

Introduction: Bangladesh is one of the most densely populated (1008 per sq. km.) countries of the world with population growth rate 1.37 percent (BBS 2017). At present total cultivable land is 8.59 million hectares, which is decreasing at the rate of about 0.73% per year. There is very little scope of increasing cultivable land but there are some scopes of increasing cropping intensity from the present cropping intensity of 192% by improving the present cropping pattern incorporating short duration crops like; Mustard, Potato, Mungbean, etc. in the rice based cropping pattern. In order to produce more food through increase the cropping intensity producing three or more crops over the same piece of land in a year and to increase the production efficiency of the individual crop by using optimum management practices. One of the dominant existing cropping patterns of Pabna is Mustard-Boro-T. Aman rice. The cultivation of low yielding varieties of Mustard and rice crops results in lower productivity of the pattern. Therefore, the improvement of the existing cropping pattern is imperative to support the most efficient use of the limited natural resources and thereby increasing crop productivity. Recently the development of short duration high yielding varieties of Mustard and rice crop by NARS institutes have created good opportunities to improve existing Mustard-Boro-T. Aman rice. The present study was undertaken to evaluate the feasibility of growing new varieties of Mustard, Boro and T. Aman rice crops in existing Mustard-Boro-T. Aman rice cropping pattern for higher total productivity and farmers income.

Description: The dry lands are prepared at the joe condition (field capacity) of the soil by breaking soil clods and leveling field. Seeds are directly sown at field capacity condition. Wet land preparation is required for rice crop establishment. Here stagnant water is accumulated either from rainfall or irrigation sources and soil is puddled and rice seedlings are transplanted. In this cropping pattern 3 crops are cultivated in sequence starting from rabi season with T. Aman rice followed by Mustard and Boro rice. The main field duration of the three crops is about 280-292 days. The crops were harvested at physiological maturity rather at harvesting maturity. The cropping pattern-based fertilizer dose was considered (BARC, 2018) rather individual crop base. Residual effect of P, K and micronutrients become available for succeeding crops and was taken into account and accordingly the fertilizer dose was adjusted. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation can be applied to prepare land at field capacity. Sometimes crop establishment can be delayed due to rainfall. Continuous cultivation of crops allows less weed infestation. However, necessary weeding may be needed to keep the crop field weed free.

Cultivation procedure of Mustard: The land is prepared by power tiller for Mustard. Prior to land preparation if the soil is very dry then light irrigation can be applied. After well preparation of land the seeds of Mustard are sown at field capacity of soil moisture on 2nd week of November. All the fertilizers are applied as basal fertilizer except half of the urea. Basal fertilizers are applied @ 90-27-32-15-1-1 kg ha^{-1} N-P-K-S-Zn-B. The Mustard variety is BARI Sorisha-17. Mustard is usually sown in broadcast @ 7.5 kg ha^{-1}. Half of the urea is top dressed at 25 days after sowing. Top dress is followed by thinning and weeding. Thin out seedlings are used as green vegetables. One or two irrigations are required and are applied as and when necessary. Curative measures are taken if Mustard is infested by pest and diseases. Mustard is harvested within first week of February.

Cultivation procedure of Boro and T. Aman rice: After the harvesting of Mustard, the land is prepared by power tiller with irrigation and puddling for transplanting of Boro and succeeding T. Aman rice. At final land preparation 1/3 urea and the full amount of all fertilizers are applied as basal. Remaining 2/3 of the urea is applied two times as top dress at about 15 and 30 days after transplanting of seedling. Fertilizers are applied @ 150-12-55-18-1.3-0 kg ha^{-1} N-P-K-S-Zn-B for Boro and @ 90-10-35-12-1 kg ha^{-1} N-P-K-S-Zn for T. Aman rice. Thirty-five days-old seedlings of Boro and Twenty-five days old seedlings of T. Aman rice are transplanted in the second week of February and last week of July. Two times hand weeding is done following the urea top dressing. Boro rice variety BRRI dhan28 and T. Aman rice variety Binadhan-17 is

used in this technology. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. Curative measures are taken against pest and diseases. Boro rice is harvested at the last week of May and T. Aman rice is harvested in the 2nd week of November.

Suitable location/ecosystem: The technology is suitable in the medium highland of High Ganges River Floodplain (AEZ-11) where irrigation facilities prevail. The cropping pattern can be practiced in clay loam to sandy loam soil. The technology can also be followed in the other medium high lands of extrapolation areas having similar soil and climatic environment.

Benefits: Rice equivalent yield (REY) of improved cropping pattern is 13.95 t ha^{-1} yr^{-1} whereas the existing pattern demonstrates 10.55 t ha^{-1} yr^{-1}. The gross margin of the improved pattern is 70-75 % higher than the existing cropping pattern.

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Fact sheet-3

Title of the technology : Improvement of existing cropping pattern T. Aman-Lentil-Sesame through inclusion of suitable high yielding varieties in High Ganges river Floodplain (AEZ-11)

Introduction: Sustainable crop production is growing concern for food and nutrition security of overcrowded population of Bangladesh. At present total cultivable land is 8.59 million hectares which is decreasing at the rate of about 0.73% per year. There is very little scope of increasing cultivable land but there are some scopes of increasing cropping intensity from the present cropping intensity of 192% by improving the present cropping pattern incorporating short duration crops pattern. In order to produce more food within a limited area, increase the cropping intensity in a year and to increase the production efficiency of the individual crop by using optimum management practices. One of the important existing cropping patterns of Pabna is T. Aman-Lentil-Sesame. The cultivation of low yielding varieties of Lentil, Sesame and rice crops in existing pattern results in lower productivity of the pattern. Recently the development of short duration high yielding varieties of Lentil, Sesame and T. Aman rice crops by NARS institutes have created good opportunities in improviong existing T. Aman-Lentil-Sesame cropping pattern and raising total productivity and farmers income.

Description: In this cropping pattern two upland crops viz., Lentil and Sesame, and one lowland crop T. Aman is cultivated. Dry land preparation for upland crop is required where lands are prepared at the joe condition (field capacity) of the soil by breaking soil clods and leveling field. The seeds of Lentil and Sesame are directly sown at field capacity of soil. Wet land preparation for is required for T. Aman rice establishment. Here stagnant water is accumulated either from rainfall or irrigation sources and soils are puddled or rice seedlings are transplanted. In this cropping pattern 3 crops are cultivated in sequence starting from rabi season with T. Aman rice followed by Lentil and Sesame. The main field duration of the three crops is about 290 days. To increase the turnaround time the crops were harvested at physiological maturity rather at harvesting maturity. The cropping pattern-based fertilizer dose was considered (BARC, 2018) rather individual crop base. The fertilizer doses need to be adjusted according to residual effect of P, K and micronutrients fertilizer were become available for succeeding crops. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation may give to prepare land at field capacity. Sometimes crop establishment can be delayed due to rainfall. Continuous cultivation of crops allows less weed infestation. However, necessary weeding may be needed to keep the crop field weed free.

Cultivation procedure of T. Aman rice: The land is prepared by power tiller with irrigation and puddling and for transplanting of T. Aman rice. Fertilizers are applied @ 90-10-35-12-1 kg ha^{-1} of N-P-K-S-Zn. All P, K, S, and Zn fertilizers should be applied as basal. N should be applied in 3 equal splits, the 1st one as immediately after seedling establishment, the 2nd one at early tillering stage and 3rd one at 5-7 days before panicle initiation. Twenty-five days old seedlings of T. Aman rice are transplanted in the last week of July. Two times hand weeding is done following the urea top dressing. T. Aman rice variety Binadhan-17 is used for this improved pattern. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. Top dress is done followed by weeding. Curative measures are taken against pest and diseases.

Cultivation procedure of Lentil: After the harvest of T. Aman rice the land is prepared by power tiller. The seeds of Lentil are broadcasted at joe condition of the soil in the third week of November. The seed rate of Lentil @ 35 kg ha^{-1}. Fertilizers are applied @ 18-30-25-18 Kg ha^{-1} of N-P-K-S. All fertilizers should be applied as basal during final land preparation. The Lentil variety BARI Masur-8 is used. Weeding is done at 25 days after sowing. Usually, one light irrigation is required at sowing for ensuring germination. Lentil is harvested in the second week of March.

Cultivation procedure of Sesame: The land is prepared by power tiller for Sesame. The land is prepared well and the seeds of Sesame are broadcasted at field capacity of soil moisture at the last week of March. Basal fertilizers are applied @ 78-18-27-20-0-0 kg ha^{-1} of N-P-K-S-Zn-B. Half of N and all nutrients should be applied as basal during final land preparation. Remaining half N should be applied as top dress at 25-30 days after sowing. The Sesame variety is BARI Til-4. Sesame is usually sown as broadcast @ 7-7.5

kg ha^{-1}. Top dress is followed by thinning and weeding. One or two irrigations are required and are applied when it is necessary (at 25-30 DAS and 55-60 DAS if the soil moisture is too low). Curative measures are taken against pest and diseases. Sesame is harvested in the third week of June.

Suitable location/ecosystem: The technology is suitable in the medium highland of High Ganges River Floodplain (AEZ-11) where T. Aman rice is grown. The cropping pattern can be practiced in clay loam to sandy loam soil. The technology can also be followed in other medium high lands of extrapolation areas having similar soil and climatic environment.

Benefits: Rice equivalent yield (REY) of improved cropping pattern is 14.00 t ha^{-1} yr^{-1} whereas the existing pattern shows 12.45 t ha^{-1} yr^{-1}. The gross margin of improved pattern is 20-25 % higher than the existing T. Aman-Lentil-Sesame cropping pattern.

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Fact sheet-4

Title of the technology: An improved cropping pattern Lentil-Jute-T. Aman for medium highland in Low Ganges river Floodplain soil in Faridpur region

Introduction: Pulse- Jute-T. Aman is an important existing cropping pattern under AEZ-12 in Faridpur which covers 6% of total cultivable land (145224 ha). Jute is one of the cash crops in that region which covers about 85 thousand hectares. In this cropping pattern, farmers use crop varieties like local for Lentil, JRO 524 for Jute and BRRI dhan39 for T. Aman. The farmers using varieties are low yielder, long duration and susceptible to different pest. Thus, introducing new and high yielding crop varieties in the existing Lentil-Jute-T. Aman cropping pattern, the pattern may be improved through BARI Masur-8, Rabi-1 and BRRI dhan75 for Lentil, Jute and T. Aman, respectively. Short duration with high yielder varieties of crops especially Lentil and T. Aman are selected to fit well in the improved cropping pattern.

Description: In this cropping pattern two upland crops viz., Lentil and Jute and one lowland crop, T. Aman is cultivated. Dry land preparation for upland crop is required where lands are prepared at the joe condition (field capacity) of the soil by breaking soil clods and leveling field. Seeds are direct sown at field capacity of soil. Wet land preparation for lowland crop is required for T. Aman establishment. Here, stagnant water is accumulated either from rainfall or irrigation sources and soil is puddled and rice seedlings are transplanted. In this cropping pattern, three crops are cultivated in sequence starting from early Rabi season with Lentil, followed by Jute and T. Aman. The main field duration of the Lentil, Jute and T. Aman is about 112-113 days, 115-116 days and 98-101 days, respectively. So careful attention is given to timely establishment of crops. Sometimes rainfall delays the establishment of next crop especially upland crops. The cropping pattern-based fertilizer dose is considered (BARC, 2018) rather individual crop base. Micronutrient fertilizers are applied once in a year. The Lentil roots after harvest are incorporated into the soil to improve soil health and reduce to some extent the fertilizer requirement of the following crops. Crop residue of pulses adds considerable amount of N for the next crop and increases availability of other nutrients. Residual effect of P, K and micronutrients become available for succeeding crops considered during fertilizer dose determination. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation may be applied to prepare land at field capacity.

Cultivation procedure of Lentil: Land is prepared by power tiller for Lentil and seed is sown as broadcast @ 35 kg ha^{-1} seed rate at field capacity of soil moisture at around mid-week to last week of November that depends on rainfall. The Lentil variety is BARI Masur-8. All the fertilizers are applied as basal following 28-24-14-9-2-1 kg ha^{-1} of N-P-K-S-Zn-B. After sowing, the land is irrigated. Curative measures are taken for controlling foot and root rot and Stemphylium blight diseases. Lentil is harvested within 3rd to 4th week of March.

Cultivation procedure of Jute: After the harvest of Lentil, land is prepared by power tiller for Jute. If necessary, irrigation is applied bringing joe condition and seed is sown as broadcast @ 6.5 kg ha^{-1} seed rate in last week of March to 1st week of April. The Jute variety is Rabi-1. Fertilizers are applied @ 140-30-25-15-4-2 kg ha^{-1} of N-P-K-S-Zn-B. Half of N and all P, K are applied as basal during final land preparation. Remaining N are top dressed at 40-45 DAS under moist soil condition. Top dress of N is followed by thinning and weeding. Usually, irrigation is not necessary. However, if needed a light irrigation may be applied as and when necessary. Main Jute is harvested in the 3rd to 4th week of July. Before harvesting of main Jute, premature (Basch pat) is also harvested on 80-85 days of main Jute.

Cultivation procedure of T. Aman rice: After harvesting of Jute, land is irrigated and puddled by power tiller for T. Aman transplanting at 2nd week of August. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. T. Aman variety is BRRI dhan75. Fertilizers are applied @ 80-15-35-8-1-0 kg ha^{-1} of N-P-K-S-Zn. All P, K, S, and Zn fertilizers are applied as basal. N are applied in 3 equal splits, the 1st one as immediately after seedling establishment, the 2nd one at early tillering stage and 3rd one at 5-7 days before panicle initiation. Twenty days old seedlings of T. Aman are transplanted. Irrigation is applied as and when necessary. Two times hand weeding is done following the urea top dressing. Top dress is

followed by weeding. Curative measures are taken if Aman is infested by pest and diseases. T. Aman is harvested in the 3rd week of November.

Suitable location/ecosystem: The technology is suitable in the medium highland of Low Ganges river floodplain soil in Faridpur region where irrigation facilities prevail. The cropping pattern can be practiced in clay loam to clay soil.

Benefits:

- The newly introduced crop for Lentil (BARI Masur-8) and Jute (Rabi-1) by replacing farmers existing cropping pattern.
- Short duration T. Aman variety, BRRI dhan75 (one week earlier) is also introduced against farmers cultivated BRRI dhan39 for timely sowing of Lentil.
- The product yield of Lentil, Jute and T. Aman is 1.71, 2.96 and 4.58 t ha^{-1}, respectively which is 106, 12 and 11% higher than that of crops under existing cropping pattern. Rice equivalent yield (REY) 18.66 t ha^{-1} yr^{-1} is in the improved cropping pattern whereas in the existing pattern is 14.64 t ha^{-1} yr^{-1}.
- Gross margin increased by 60% over existing pattern and the marginal benefit cost ratio (MBCR) of the improved cropping pattern is 2.65.

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Fact sheet-5

Title of the technology: An improved cropping pattern Mustard-Jute-T. Aman for medium highland in Low Ganges river Floodplain soil in Faridpur region

Introduction: Oil crop- Jute-T. Aman is an important existing cropping pattern in Faridpur covers 10,520 ha of total cultivable land which is about 7%. Jute is one of the cash crops in this region also which covers about 85 thousand hectares. In this cropping pattern, farmers use crop varieties like local for Mustard, JRO 524 for Jute and BRRI dhan39 for T. Aman. The farmers cultivated varieties are low yielder, long duration and susceptible to different pests. Thus, introducing new and high yielding crop varieties in the existing Mustard-Jute-T. Aman cropping pattern, the pattern may be improved through BARI Sarisha-18, Rabi-1 and BRRI dhan75 for Mustard, Jute and T. Aman, respectively. Short duration with high yielder varieties of crops especially Mustard and T. Aman are selected to fit well in the improved cropping pattern.

Description: In this cropping pattern two upland crops viz., Mustard and Jute and one lowland crop, T. Aman is cultivated. Dry land preparation for upland crop is required where lands are prepared at the joe condition (field capacity) of the soil by breaking soil clods and leveling field. Seeds are direct sown at field capacity of soil. Wet land preparation for lowland crop is required for T. Aman establishment. Here stagnant water is accumulated either from rainfall or irrigation sources and soil is puddle and rice seedlings are transplanted. In this cropping pattern, three crops are cultivated in sequence starting from rabi season with Mustard, followed by Jute and T. Aman. The main field duration of the Mustard, Jute and T. Aman is about 100-102 days, 120-122 days and 103 days, respectively. Sometimes rainfall delays the establishment of next crop especially upland crops. The cropping pattern base fertilizer dose is considered (BARC, 2018) rather individual crop base. Micronutrient fertilizers are applied once in a year. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation may give to prepare land at field capacity.

Cultivation procedure of Mustard: Land is prepared by power tiller for Mustard and seed is sown as broadcast @ 7 kg ha^{-1} seed rate at field capacity of soil moisture at around last week of November. The Mustard variety is BARI Sarisha-18. Fertilizers are applied @ 120-36-40-15-2-1 kg ha^{-1} of N-P-K-S-Zn-B. Two third of N and full amount of P, K, S, Zn and B are applied as basal during final land preparation. The remaining N is applied as top dress at the time of flower initiation stage (25 DAS-30 DAS). After sowing, the land is irrigated. Another irrigation is required during N top dressing. Curative measures are taken for controlling Alternaria blight and aphid infestation. Mustard is harvested within 1st week of March.

Cultivation procedure of Jute: After harvesting of Mustard, land is prepared by power tiller for Jute. If necessary, irrigation is applied bringing joe condition and seed is sown as broadcast @ 6.5 kg ha^{-1} seed rate in 4th to last week of March. The Jute variety is Rabi-1. Fertilizers are applied @ 140-30-25-15-4-2 kg ha^{-1} of N-P-K-S-Zn-B. Half of N and all P, K are applied as basal during final land preparation. Remaining N are top dressed at 40-45 DAS under moist soil condition. Top dress of N is followed by thinning and weeding. Usually, irrigation is not necessary. However, if needed a light irrigation may be applied as and when necessary. Main Jute is harvested in the 3rd to 4th week of July. Before harvesting of main Jute, premature (Basch pat) is also harvested on 80-85 days of main Jute.

Cultivation procedure of T. Aman rice: After harvesting of Jute, land is irrigated and puddled by power tiller for T. Aman transplanting at 2nd week of August. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. T. Aman variety is BRRI dhan75. Fertilizers are applied @ 80-15-35-8-1-0 kg ha^{-1} of N-P-K-S-Zn. All P, K, S, and Zn fertilizers are applied as basal. N are applied in 3 equal splits, the 1st one as immediately after seedling establishment, the 2nd one at early tillering stage and 3rd one at 5-7 days before panicle initiation. Twenty days old seedlings of T. Aman are transplanted. Irrigation is applied in the first month of transplanting as and when necessary. Two times hand weeding is done following the urea top dressing. Top dress is followed by weeding. Curative measures are taken if Aman is infested by pest and diseases T. Aman is harvested in the 3rd week of November.

Suitable location/ecosystem: The technology is suitable in the medium highland of Low Ganges river

floodplain soil in Faridpur region where irrigation facilities prevail. The cropping pattern can be practiced in clay loam to clay soil.

Benefits:

- The newly introduced Mustard var. BARI Sarisha-18 and Jute var. Rabi-1 replacing in farmers existing cropping pattern.
- Besides, short duration T. Aman var. BRRI dhan75 (one week earlier) is also introduced against farmers cultivated BRRI dhan39.
- The product yield of Mustard, Jute and T. Aman is 1.71, 3.02 and 4.45 t ha^{-1}, respectively which is 88, 16 and 12% higher than that of crops under existing cropping pattern. Rice equivalent yield (REY) 17.34 t ha^{-1} yr^{-1} is in the improved cropping pattern whereas in the existing pattern is 13.95 t ha^{-1} yr^{-1}
- Gross margin increased by 45% over existing pattern and the marginal benefit cost ratio (MBCR) of the improved cropping pattern is 2.25.

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Fact sheet-6

Title of the technology: An alternate cropping pattern Tomato + Lettuce -Chilli /Sweet Gourd in Dragon Fruit orchard near by the Homestead for highland in Low Ganges river Floodplain Soil in Faridpur region

Introduction: The newly established fruit gardens are used to grow seasonal vegetables crops following intercropping system in Dragon fruit orchard for increasing cropping intensity and productivity. Before getting fruit bearing stage of Dragon fruits, the blank space between fruit plants is used as vegetables production by the farmers. Normally, farmers feel interest in hybrid variety for Tomato and Sweet gourd but looser due to non-quality seed. Relay of chilli with Sweet gourd is a common practice in Faridpur. Farmers grow chilli in summer (February to March) season in Faridpur district. Seeds of different creeper vegetables like Sweet gourd is sown (July-August) at the end of harvesting of chilli when the plants become near to die (become dry) as supporting materials (as trellis). The technology is being practiced by the farmers to escape/reduce the cost of trellis, early marketing of creeper vegetables and getting higher income as well. But the farmers do not get satisfactory yield due to irrational use of fertilizer and local variety. Again, introducing Lettuce in Tomato as intercrop with BARI varieties, the pattern may be improved with higher income.

Description: The vegetables based alternate cropping pattern (Tomato + Lettuce-Chilli/Sweet gourd) is used in the nearby homestead area. Farmers cultivate only sole Tomato but intercropping of Lettuce with BARI developed Tomato might be a good practice. Farmers use hybrid (Tomato and Sweet gourd) varieties in their existing pattern whereas, BARI Tomato-18, BARI Lettuce-1, BARI Morich-2 and BARI Misti Kumra-2 are used in alternate cropping pattern. Sweet gourd is cultivated as relay with chilli where the matured chilli plant act as supporter of Sweet gourd. Sweet gourd seedling is transplanted before two months of fully harvesting of chilli. Thus, the main field duration of the Tomato + Lettuce, chilli and Sweet gourd is about 108 days, 205 days and 74 days. The individual crop-based fertilizer dose is considered. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry, additional irrigation may give to prepare land at field capacity.

Cultivation procedure of Tomato + Lettuce: Land is prepared by power tiller. Seedling of Tomato and Lettuce is sown in line maintaining 60 cm x 40 cm and 30 cm x 20 cm spacing for Tomato and Lettuce, respectively. The Lettuce is transplanted along with the Dragon fruit line (between two plant of Dragon). Thirty days old seedlings are planted on last week of December. The cultivated variety of Tomato and Lettuce is BARI Tomato-18 and BARI Lettuce-1, respectively. Fertilizers are applied @ 104-45-64-24-2.7-1.3 kg ha^{-1} of N-P-K-S-Zn-B with 5 t ha^{-1} organic fertilizer. Half of organic fertilizer and all of P, S, Zn and B are applied as basal during final land preparation. Remaining organic manure are applied in pits before planting of seedling. One third of N are applied at 15 DAP as ring method. Rest one third N and half of K Soil are applied at 40-45 and 70-75 DAP, respectively as ring method. No weeding is done because of providing black polymulch on Tomato plant. Curative measures are taken for controlling pest and diseases as and when necessary. Harvesting period is 3rd week of February to 3rd week of April for Tomato and 2nd to 3rd week of February for Lettuce.

Cultivation procedure of chilli: Land is prepared by power tiller. Seedling of chilli is sown in line sowing with spacing 60 cm x 50 cm. Thirty days old seedlings are planted on 3rd week of April. The variety of chilli is BARI Morich-2. Fertilizers are applied @ 130-60-50-15-1.5-1.5 kg ha^{-1} of N-P-K-S-Zn-B. All P, K, S, Zn and B; and half of N are applied as basal during final land preparation. Remaining N is applied in 3 equal splits at 25, 50 and 70 DAP. Curative measures are taken for controlling pest and diseases. Harvesting is started at 3rd week of June to 2nd week of November.

Cultivation procedure of Sweet gourd: Seedling of Sweet gourd is transplanted as line sowing in the existing chilli field and spacing is 2.4 m x 2 m. Seedlings are planted on 3rd week of September. The variety of Sweet gourd is BARI Misti Kumra-2. Fertilizers are applied @ 100-50-60-0-0 kg ha^{-1} of N-P-K-S-Zn-B with 2 t ha^{-1} organic fertilizer. All of P, S, Zn and B; and one third of N are applied in pit 5-7 days before planting. Remaining N are applied around the plant as side dressing at 15, 45 and 75 DAT. Harvesting is started at 1st to last week of November.

Suitable location/ecosystem: The technology is suitable in the highland of Low Ganges river floodplain soil in Faridpur region where irrigation facilities prevail. The cropping pattern can be practiced in clay loam to sandy loam soil.

Benefits:

- The newly introduced crop in the farmers existing cropping pattern is BARI Lettuce-1 with Tomato in rabi season. A vegetables-based cropping patter is introduced in nearby homestead area.
- The product yield of Tomato, Lettuce, Chilli and Sweet gourd is 26.20, 6.40, 6.36 and 11.62 t ha^{-1}, respectively. The Chilli and Sweet gourd yield are 3% and 11% higher than that of crops under existing cropping pattern.
- Gross margin increased by 7% over existing pattern Tomato-Chilli/Sweet gourd and the marginal benefit cost ratio of the improved cropping pattern is 2.67.

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Fact sheet-7

Title of the technology: An improved cropping pattern for medium high land in Old Brahmaputra Floodplain (AEZ-9) and Young Brahmaputra and Jamuna Floodplain (AEZ-8) soil: Boro-T. Aman rice -Mustard

Introduction: Bangadesh is a densely populated country of the world (Worldmeters, 2021). At present total cultivable land is 8.59 million hectares which is decreasing at the rate of about 0.73% per year. There is very little scope of increasing cultivable land but there are some scopes of increasing cropping intensity from the present cropping intensity of 192% by improving the present cropping pattern incorporating short duration crops like; Mustard, Potato, Mungbean, etc. in the rice based cropping pattern. In order to produce more food within a limited area, two most important options to be adopted are i) to increase the cropping intensity producing three or more crops over the same piece of land in a year and ii) to increase the production efficiency of the individual crop by using optimum management practices. The existing ten major cropping patterns of Tangail region among which Fallow-Boro-T. Aman rice is ranked one and which covers about 58 % of the total cultivable land (DAE, Tangail 2018). A huge part of land remains fallow 2 to 3 months after harvest of T. Aman rice in Tangail region. So, there is a great scope of increasing cropping intensity as well as crop productivity here. Recently with the development of short duration varieties of Potato, Mustard, and pulses opportunities have been created to accommodate three crops in the same piece of land in a year. Considering farmers' choice, land and soil suitability of crops the present study was undertaken to evaluate the feasibility of growing three crops in a year in a piece of land by incorporating Mustard new variety in the existing cropping pattern Fallow-Boro-T. Aman rice. Thus, a new cropping pattern, Mustard - Boro-T. Aman rice is developed with diverse crop combination where two rice and one oil seed crop are included.

Description: In this cropping pattern three crops viz., Mustard and two rice crops. Dry land preparation for upland crop is required where lands are prepared at the joe condition (field capacity) of the soil by breaking soil clods and leveling field. Seeds are direct sown at field capacity of soil. Soil is puddle and rice seedlings are transplanted. The main field duration of the four crops is about 305 days. To increase the turnaround time the crops were harvested at physiological maturity rather at harvesting maturity. Fields are released about seven days before the establishment of preceding crops. Sometimes rainfall delays the establishment of next crop as maintaining soil moisture at field capacity is necessary during establishment of crops. The cropping pattern base fertilizer dose of similar cropping pattern was considered (BARC, 2018) rather individual crop base. Residual effect of P, K and micronutrients become available for succeeding crops and was taken into account and accordingly the fertilizer dose was adjusted. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation may give to prepare land at field capacity. Delay in crop establishment is sometimes taken place. Rainfall may interfere with the land preparation. Continuous cultivation of crops allows less weed infestation. In most cases second weeding was not necessary.

Cultivation procedure of Mustard: Land is prepared by power tiller for Mustard. Prior to land preparation if soil is very dry irrigation is applied. Land is prepared well and Mustard is line sown at field capacity of soil moisture at around mid-November. All the fertilizers are applied as basal fertilizer except half of the urea which is applied as top dress. Basal fertilizers are applied @ 250-170-85-150-5-10 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zink sulfate and Boron. The Mustard variety is BARI Sarisha-14. Mustard is usually sown in broadcast @ 7 kg ha^{-1}. Half of the urea is top dressed at 25 days after sowing. Top dress is followed by thinning and weeding. Thin out seedlings are used as green vegetables. One or two irrigations are required and are applied as and when necessary. Curative measures are taken if Mustard is infested by pest and diseases. Mustard is harvested within first week of February.

Cultivation procedure of Boro and T. Aman rice: After the harvest of Mustard land is irrigated and puddle and prepared by power tiller for Boro and T. Aman rice transplanting. At final land preparation fertilizers are applied as basal fertilizer except 2/3 of the urea which is applied as top dress two times at about 15 and 30 DAT. Fertilizers are applied @ 140-20-60-20-2-0 kg of NPKSZn ha^{-1} for Boro and @ 70-15-36-8-2.5-0 kg of NPKSZn ha^{-1} for T. Aman rice. Thirty five days old seedlings of Boro and Twenty

five days old seedlings of T. Aman rice are transplanted in the second week of February and last week of July. Two times hand weeding is done following the urea top dressing. Boro rice variety is BRRI dhan29 and T. Aman rice variety is BRRI dhan72. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. One third of the urea is top dressed at 15 and 25 days after sowing. Top dress is followed by weeding. Curative measures are taken against pest and diseases. Boro rice is harvested middle of June and T. Aman rice is harvested in the last week of October.

Suitable location/ecosystem: The technology is suitable in the medium highland of AEZ-8 and AEZ-9 where irrigation facilities prevail. The cropping pattern can be practiced in clay loam to sandy loam soil. The technology can also be followed in the other medium high lands in pocket areas if irrigation facilities exist.

Benefits: Rice equivalent yield of the improved cropping pattern is 16.59 t ha^{-1}. The gross margin is 57% higher than the existing Boro-T. Aman-Fallow cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 4.49.

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Fact sheet-8

Title of the technology: An improved cropping pattern for medium high land in Old Brahmaputra Floodplain (AEZ-9) and Young Brahmaputra and Jamuna Floodplain (AEZ-8) soil: Okra-T. Aman rice -Cabbage

Introduction: There is very little scope of increasing cultivable land but there are some scopes of increasing cropping intensity from the present cropping intensity of 192% by improving the present cropping pattern incorporating short duration crops pattern. In order to produce more food within a limited area, two most important options to be adopted are i) to increase the cropping intensity producing three or more crops over the same piece of land in a year and ii) to increase the production efficiency of the individual crop by using optimum management practices. Therefore, an adaptation of alternative cropping patterns to support the most efficient use of the limited natural resources is a prime need for recent days. A huge part of land remains fallow 2 to 3 months after harvest of T. Aman rice in Tangail region. So, there is a great scope of increasing cropping intensity as well as crop productivity by growing three crops in a year in a piece of land by incorporating Okra in the existing cropping pattern Brinjal-T. Aman-Cabbage. Thus, a new cropping pattern, Okra-T. Aman rice-Cabbage is developed with diverse crop combination where two vegetables and one rice are included.

Description: In this cropping pattern two upland crops viz., Okra and Cabbage and one lowland crop T. Aman is cultivated. Dry land preparation for upland crop is required where lands are prepared at the joe condition (field capacity) of the soil by breaking soil clods and leveling field. Seeds are direct sown at field capacity of soil. Wet land preparation for lowland crop is required for T. Aman establishment. Here stagnant water is accumulated either from rainfall or irrigation sources and soil is puddle and rice seedlings are transplanted. In this cropping pattern 3 crops are cultivated in sequence starting say from early Kharif season with Okra followed by T. Aman and Cabbage. The main field duration of the three crops is about 290 days. So careful attention was given to timely establishment of crops. The crops were harvested at physiological maturity rather at harvesting maturity. Fields are released about seven days before the establishment of preceding crops. Sometimes rainfall delays the establishment of next crop as maintaining soil moisture at field capacity is necessary during establishment of upland crops. The cropping pattern base fertilizer dose was considered (BARC, 2018) rather individual crop base. Micronutrient fertilizers were applied once in a year. Residual effect of P, K and micronutrients become available for succeeding crops and was taken into account and accordingly the fertilizer dose was adjusted. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation may give to prepare land at field capacity. Delay in crop establishment is sometimes taken place. Rainfall may interfere with the land preparation of upland crops. Continuous cultivation of crops allows less weed infestation.

Cultivation procedure of Okra: Land is prepared by power tiller for Okra. Land is prepared well and Okra is line sown at field capacity of soil moisture at around mid-March. Basal fertilizers are applied @ 70-20-75 kg of NPK ha^{-1}. All P, K and one fourth of N fertilizers are applied as basal during final land preparation. Rest three fourth of N are applied in 3 equal splits, at 20, 40 and 60 days after sowing. The Okra variety is BARI Dherosh-2. Okra is usually sown in line with a spacing of 45 cm x 30 cm @ 5 kg ha^{-1}. Top dress is followed by thinning and weeding. One or two irrigations are required and are applied as and when necessary. Curative measures are taken against pest and diseases. Okra is harvested from 20 April to 25 June.

Cultivation procedure of T. Aman rice: After the harvest of Okra land is irrigated and puddle and prepared by power tiller for T. Aman rice transplanting. At final land preparation fertilizers are applied as basal fertilizer except 2/3 of the urea which is applied as top dress two times at about 15 and 30 DAT. Fertilizers are applied @ 70-10-40-10-2 kg of NPKSZn ha^{-1}. Twenty-five days old seedlings of T. Aman rice are transplanted in the last week of July. Two times hand weeding is done following the urea top dressing. T. Aman rice variety is BRRI dhan72. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. One third of the urea is top dressed at 15 and 35 days after sowing. Top dress is followed by weeding. Curative measures are taken against pest and diseases.

Cultivation procedure of Cabbage: After the harvest of T. Aman rice land is prepared by power tiller. Cabbage seedlings are transplanted at joe condition of the soil in the second week of November. Cabbage is transplanted in line @ 0.4 kg seed per hectare. Seedling spacing is 60 cm x 45 cm and one seedling per pit. Fertilizers are applied @ 138-40-125-20-0-1 kg ha^{-1} of NPKSB. Except N, all P, S, B and half of K fertilizers are applied as basal during final land preparation. N and rest half of K is applied in 3 equal splits, at 15, 30 and 60 days after transplanting in ring method. The Cabbage variety is Autumn queen. At 25 days after transplanting weeding is done. Usually, one or two irrigations are required and light irrigation may be applied as and when necessary. Cabbage is harvested in the first and second week of February.

Suitable location/ecosystem: The technology is suitable in the medium highland of AEZ-9 and AEZ-8 where irrigation facilities prevail. The cropping pattern can be practiced in clay loam to sandy loam soil. The technology can also be followed in the other medium high lands in pocket areas if irrigation facilities exist.

Benefits: Rice equivalent yield of the improved cropping pattern is 42.21 t ha^{-1}. The gross margin is 27% higher than the existing Brinjal-T. Aman- Cabbage cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 6.98.

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Fact sheet-9

Title of the technology: Development of four crops based cropping pattern Potato-Mungbean-T. Aus-T. Aman at Jamalpur and Sherpur region

Introduction: Bangladesh is a densely populated country of the world (Worldmeters, 2017). Total cultivable land of our country is about 7.95 million hectare (BBS, 2016) which is decreasing at the rate of about 0.44% per year. There is a little scope of increasing cultivable land in our country but it is possible to increase cropping intensity from the present situation by including more crop in cropping pattern. Incorporating Potato, Mustard, Mungbean, garden pea, T. Aus in the fallow period of rice-based cropping pattern could be an option. Sustainable crop production in Bangladesh through improvement of cropping pattern in rice based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and creation of job opportunity. In order to produce more food within a limited area, two most important options to be adopted are i) to increase the cropping intensity producing three or more crops over the same piece of land in a year and ii) to increase the production of the individual crop by using optimum management practices.

Description: In this cropping pattern, four crops viz., Potato, Mungbean, T Aus and T. Aman is cultivated. Land preparation is required for individual crop. For Potato and Mungbean, the lands are prepared at the Joe condition (field capacity) of the soil and leveling the field. Potato tuber is sown in furrow while Seeds of Mungbean are broadcasted sown at field capacity of soil. Wet land preparation for T. Aus and T. Aman crops are required for quick root development. Here stagnant water is accumulated either from rainfall or irrigation sources and soil is puddled and rice seedlings are transplanted. In this cropping pattern 4 crops are cultivated in sequence starting from Rabi season with Potato followed by Mungbean, T. Aus and T. Aman. The main field duration of the four crops is about 324 days. So, careful attention was given to timely establishment of crops. The crops were harvested at physiological maturity rather at harvesting maturity. Fields are released about seven days before the establishment of preceding crops. Sometimes, rainfall delays the establishment of next crop. Such cases, irrigation should be needed as maintaining soil moisture at field capacity during establishment of different crops.

Cultivation procedure of Potato: Land is prepared by power tiller for Potato. Prior to land preparation subsequent irrigation is given if soil is dry. After optimum land preparation, Potato tuber is sown in furrow at field capacity of soil moisture at Last week of November. Fertilizers are applied @ 325-200-226-100-7.5-6 kg ha^{-1} of Urea, TSP, MoP, Gypsum, Zinc sulphate and Boron respectively. Half of urea and all other fertilizers were applied as basal and rest half of urea was top dressed at 30-35 DAS. Top dress is done before earthing up. The Potato variety is BARI Alu-25. Potato tuber is usually sown in line with a spacing of 60 cm x 25 cm @ 1.5-2.0 t ha^{-1}. Earthing up and irrigation should be done at 30-35 DAS. Carbofuran @15 kg ha^{-1} should be applied for controlling soil insects. Curative measures are taken if Potato is infested by pest and diseases. Potato is harvested at 3rd week of February.

Cultivation procedure of Mungbean: After the harvest of Potato, land is prepared by power tiller for Mungbean cultivation. If necessary, irrigation is applied and at joe condition Mungbean is sown at 1st week of March. Fertilizers are applied @ 43-75-50-0-0-0 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zinc sulphate and Boron respectively. All fertilizers are applied during final land preparation. The Mungbean variety is BARI Mung-6. Mungbean is broadcasted @ 25 kg ha^{-1}. One weeding should be done at 25-30 DAS. Usually, irrigation is not necessary. Mungbean is harvested at 2nd week to 3rd week of May.

Cultivation procedure of T. Aus rice: After harvest of Mungbean, land is irrigated and puddled by power tiller for T. Aus transplanting. Fertilizers are applied @ 150-75-76-55-0-0 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zinc sulphate and Boron, respectively. All fertilizers are applied during final land preparation except urea. Urea was top dressed equally two splits at 20 and 45 DAT. Top dress is followed by weeding. Twenty-five-day old seedlings of T. Aus rice are transplanted at 4th week of May. If necessary, irrigation is applied in the growing season. T. Aus variety is BRRI dhan48. Seedlings are transplanted at 20 x 15 cm apart with 2-3 seedlings per hill. Curative measures are taken if Aus are infested by pest and diseases. T. Aus are harvested at 3rd week of August.

Cultivation procedure of T. Aman: After the harvest of T. Aus, the land is irrigated and puddled by power tiller for T. Amantransplanting. Fertilizers are applied @ 178-120-70-62-11-0 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zinc sulphate and Boron, respectively. All fertilizers are applied during final land preparation except urea. Urea is top dressed equally two splits at 20 and 45 DAT. Top dress is followed by weeding. Twenty-five-to-thirty-day old seedlings of T. Aman are transplanted at 4th week of August. Irrigation is applied if necessary. T. Aman variety is BRRI dhan49. Seedlings are transplanted at 20 x 15 cm apart with 2-3 seedlings per hill. Carbofuran @15 kg ha^{-1} should be applied for controlling stem borer. Curative measures are taken if Aman rice is infested by pest and diseases. T. Aman is harvested at 2nd week of November.

Suitable location/ecosystem: The technology is suitable in the medium highland of Sherpur and Jamalpur region where irrigation facilities prevail. The cropping pattern can be practiced in Sherpur, Jamalpur and Mymensingh and also can be followed in the highland and medium highlandof other areas of the country where irrigation facilities are available.

Benefits: Rice equivalent yield of the alternate cropping pattern is 26.8 t ha^{-1}. The gross margin is 226% higher than the existing Boro-Fallow-T. Aman cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 1.89.

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Fact sheet-10

Title of the technology: Development of four crop-based cropping pattern Garden pea-Boro-T. Aus-T. Aman at Jamalpur and Sherpur region

Introduction: Bangladesh is a densely populated country of the world (Worldmeters, 2017). Total cultivable land of our country is about 7.95 million hectare (BBS, 2016) which is decreasing at the rate of about 0.44% per year. There is a little scope of increasing cultivable land in our country but it is possible to increase cropping intensity from the present situation by including more crops in cropping pattern. Incorporating Potato, Mustard, Mungbean, garden pea, T. Aus in the fallow period of rice-based cropping pattern could be an option. Sustainable crop production in Bangladesh through improvement of cropping pattern in rice based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and creation of job opportunity. In order to produce more food within a limited area, two most important options to be adopted are i) to increase the cropping intensity producing three or more crops over the same piece of land in a year and ii) to increase the production of the individual crop by using optimum management practices.

Description: In this cropping pattern, four crops viz., Garden pea, Boro, T Aus and T. Aman is cultivated. Land preparation is required for individual crop. For garden pea, the land is prepared at the joe condition (field capacity) of the soil and leveling the field. Garden pea seed is sown in line 25 cm x 5 cm apart. Wet land preparation for Boro, T. Aus and T. Aman crops are required for quick root development. Here stagnant water is accumulated either from rainfall or irrigation sources and soil is puddle and rice seedlings are transplanted. In this cropping pattern 4 crops are cultivated in sequence starting from Rabi season with garden pea followed by Boro, T. Aus and T. Aman. The main field duration of the four crops is about 323 days. So, careful attention was given to timely establishment of the crops. The crops were harvested at physiological maturity rather at harvesting maturity. Fields are released about seven days before the establishment of preceding crops. Sometimes, rainfall delays the establishment of next crop. Such cases, irrigation should be needed as maintaining soil moisture at field capacity during establishment of different crops.

Cultivation procedure of gardenpea: Land is prepared by power tiller for garden pea. Prior to land preparation irrigation is applied if soil is very dry. Land is prepared well and garden pea is line sown at field capacity of soil moisture at 3rd week of November. Fertilizers are applied @ 100-150-100-0-0-0 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zinc sulphate and Boron, respectively. Half of urea and all other fertilizers were applied as basal and rest half of urea was top dressed at 20-25 DAS. Top dress is followed by weeding. The garden pea variety is BARI Motor shuti-3. Gardenpea is usually sown in line with a spacing of 20 cm x 5 cm @ 80-85 kg ha^{-1} seed. Usually, irrigation is not necessary. Carbofuran @15 kg ha^{-1} should be applied for controlling soil insects. Curative measures are taken if garden pea is infested by pest and diseases. Garden pea is harvested at Last week of January.

Cultivation procedure of Boro: After the harvest of garden pea, land is irrigated and puddled by power tiller for Boro transplanting. Fertilizers are applied @ 217-150-80-56-10-0 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zinc sulphate and Boron, respectively. All fertilizers are applied during final land preparation except urea. Urea was top dressed equally at 20 and 50 DAT. Top dress is followed by weeding. Thirty five to forty day old seedlings of Boro are transplanted at 1st week of February. Irrigation is applied at 15-20 times after transplanting and continued up to 15 days before harvesting. Boro variety is Hybrid sakka. Seedling are transplanted at 20 cm x 15 cm apart with 2-3 seedlings per hill. Carbofuran @15 kg ha^{-1} should be applied for controlling stem borer. Curative measures are taken if Boro rice is infested by pest and diseases. Boro is harvested at 2nd week of May.

Cultivation procedure of T. Aus: After the harvest of Boro, land is irrigated and puddled by power tiller for T. Aus transplanting. Fertilizers are applied @ 150-75-76-55-0-0 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zinc sulphate and Boron, respectively. All fertilizers are applied during final land preparation except urea. Urea was top dressed equally two splits at 20 and 50 DAT. Top dress is followed by weeding. Twenty five day old seedlings of T. Aus are transplanted at 3rd week of May. Irrigation is applied due to requirement

of the crop at whole season. T. Aus variety is BRRI dhan48. Seedlings are transplanted at 20 cm x 15 cm apart with 2-3 seedlings per hill. Carbofuran @15 kg ha^{-1} should be applied for controlling stem borer. Curative measures are taken if Aus rice are infested by pest and diseases. T. Aus is harvested at 2nd week of August.

Cultivation procedure of T. Aman: After the harvest of T. Aus, land is irrigated and puddled by power tiller for T. Aman transplanting. Fertilizers are applied @ 178-120-70-62-11-0 kg ha^{-1} of Urea, TSP, MOP, Gypsum, Zinc sulphate and Boron, respectively. All fertilizers were applied during final land preparation except urea. Urea was top dressed equally in two splits at 20 and 45 DAT. Top dress is followed by weeding. Twenty five to thirty day old seedlings of T. Aman are transplanted at 3rd week of August. T. Aman variety is BRRI dhan49. Seedlings are transplanted 20 cm x 15 cm apart with 2-3 seedlings per hill. Subsequent irrigation may be applied as and when necessary. Carbofuran @15 kg ha^{-1} should be applied for controlling stem borer. Curative measures are taken if Aman is infested by pest and diseases. T. Aman is harvested at 2nd week of November.

Suitable location/ecosystem: The technology is suitable in the high land to medium highland of Sherpur region where irrigation facilities prevail. The cropping pattern can be practiced in Sherpur, Jamalpur and Mymensingh and also can be followed in the high lands and medium highlands of other areas of the country where irrigation facilities are available.

Benefits: Rice equivalent yield of the alternate cropping pattern is 29.39 t ha^{-1}. The gross margin is 370% higher than the existing Boro-Fallow-T. Aman cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 2.10.

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Fact sheet-11

Title of the technology: An improved cropping pattern for highland in Madhupur tract soil: Mustard-Mungbean-T. Aus-Black gram

Introduction: There is about 0.4 million ha of highland in Bangladesh where water does not stagnant at all in rainy season. In Madhupur Tract, soil exhibits relief with slight undulation and the highlands are locally known as chala land. These soils dry up quickly as rain water seepage out to neighboring medium highland. Soils are clay to clay loam in texture. After rainfall or irrigation, soils crack and moisture comes out even from deep layer and soils dry up quickly and hence become drought prone. Presently in many of these areas irrigation facilities are available and in the areas upland crops like, vegetables are generally cultivated or often remain fallow. Even in this area, rice cultivation in rainy season is also possible with partial irrigation. To bring this area under full fledge cultivation round the year, different upland crops and a rice crop was planned to cultivate in 4-crops based cropping pattern and a new 4-crops based cropping pattern was developed. Short duration varieties of crops were selected to fit well in the improved cropping pattern. In this cropping pattern, in Rabi season mustard is cultivated which is followed by mungbean. After mungbean, late T. Aus rice is cultivated which is little pushed towards rainy season so that it can receive enough rainfall in rainy season. After T. Aus harvest, black gram is cultivated.Thus a new cropping pattern, Mustard-Mungbean-T. Aus-Black gram is developed with diverse crop combination where two different pulses, one oil seed crop and one cereal are included.

Description: In this cropping pattern three upland crops viz., mustard, mungbean and blackgram and one lowland crop, T. Aus is cultivated. Dry land preparation for upland crop is required where lands are prepared at the joe condition (field capacity) of the soil by breaking soil clods and leveling field. Seeds are direct sown at field capacity of soil. Wet land preparation for lowland crop is required for T. Aus establishment. Here stagnant water is accumulated either from rainfall or irrigation sources and soil is puddle and rice seedlings are transplanted. In this cropping pattern, 4 crops are cultivated in sequence starting say from early Rabi season with mustard, followed by mungbean, T. Aus and blackgram. The main field duration of the four crops is about 310 days. So careful attention was given to timely establishment of crops. To increase the turnaround time, the crops were harvested at physiological maturity rather at harvesting maturity. Fields are released about seven days before the establishment of preceding crops. Sometimes rainfall delays the establishment of next crop as maintaining soil moisture at field capacity is necessary during establishment of upland crops. The cropping pattern base fertilizer dose of similar cropping pattern was considered (BARC, 2018) rather individual crop base. Micronutrient fertilizers were applied once in a year. The brown biomass of blackgram and mungbean after harvest is incorporated into the soil to improve soil health and reduce to some extent the fertilizer requirement of the following crops. Brown crop residue of pulses adds considerable amount of N for the next crop and increases availability of other nutrients. Residual effect of P, K and micronutrients become available for succeeding crops and was taken into accountand accordingly the fertilizer dose was adjusted. Irrigation and water management schedule for sequential cropping is same as for individual crops. If the lands remain dry before land preparation additional irrigation may give to prepare land at field capacity. Delay in crop establishment is sometimes taken place. Rainfall may interfere with the land preparation of upland crops. Continuous cultivation of crops allows less weed infestation. In most cases second weeding was not necessary except T. Aus rice.

Cultivation procedure of mustard: Land is prepared by power tiller for mustard. Prior to land preparation if soil is very dry irrigation is applied. Land is prepared well and mustard is line sown at field capacity of soil moisture at around mid-November. All the fertilizers are applied as basal fertilizer except half of the urea which is applied as top dress. Basal fertilizers are applied @ 250-170-85-150-5-10 kg/ha of Urea, TSP, MOP, Gypsum, Zinc sulfate and Boron. The mustard variety is BARI Sarisha-14. Mustard is usually sown in line with a spacing of 30 cm x continuous @ 7 kg/ha. Half of the urea is top dressed at 25 days after sowing. Top dress is followed by thinning and weeding. Thin out seedlings are used as green vegetable. One or two irrigations are required and are applied as and when necessary. Curative measures are taken if mustard is infested by pest and diseases. Mustard is harvested within first week of February.

Cultivation procedure of Mungbean: After the harvest of mustard, land is prepared by power tiller for mungbean. If necessary irrigation is applied and at joe condition mung bean is sown in 3rd week of February. All the fertilizers are applied as basal fertilizer except half of the urea which is applied as top dress. Fertilizers are applied @ 45-90-40-55-10 kg/ha of Urea, TSP, MOP, Gypsum and Boron. The Mungbean variety is BARI Mung-6. Mungbean is usually sown in line with a spacing of 30 cm x continuous @ 25 kg/ha. Half of the urea is top dressed at 25 days after sowing. Top dress is followed by thinning and weeding. Usually irrigation is not necessary. However, if needed a light irrigation may be applied as and when necessary. Mungbean is harvested in the first week of May.

Cultivation procedure of T. Aus: After the harvest of mungbean, land is irrigated and puddled and prepared by power tiller for T. Aus transplanting. At final land preparation fertilizers are applied as basal fertilizer except 2/3 of the urea which is applied as top dress two times at about 15 and 30 DAT. Fertilizers are applied @ 135-50-80 kg/ha of Urea, TSP and MOP. Twenty day-old seedlings of T. Aus is transplanted in the middle of May. If necessary, irrigation is applied in the first month of transplanting. When rainy season starts the crop is usually grown as rainfed. Two times hand weeding is done following the urea top dressing. T. Aus variety is BRRI dhan48. Seedling spacing is 20 cm x 15 cm and numbers of seedlings are 2-3 per hill. One third of the urea is top dressed at 15 and 25 days after sowing. Top dress is followed by weeding. Usually irrigation is not necessary. However, if needed a light irrigation may be applied as and when necessary. Curative measures are taken if Aus is infested by pest and diseases T. Aus is harvested in the middle of August.

Cultivation procedure of Blackgram: After the harvest of T. Aus, land is prepared by power tiller. Blackgram seeds are sown at joe condition of the soil in the first week of September. Blackgram is line sown @ 30 kg/ha. All the fertilizers are applied as basal fertilizer. Fertilizers are applied @ 45-90-40-55-10 kg/ha of Urea, TSP, MOP, Gypsum and Boron. The blackgram variety is BARI Mash-4. Blackgram is usually sown in line with a spacing of 30 cm x continuous. At 25 days after sowing thinning and weeding is done. Usually irrigation is not necessary. However, if needed a light irrigation may be applied as and when necessary. Blackgram is harvested in the first week of November.

Suitable location/ecosystem: The technology is suitable in the highland of Madhupur Tract soil where irrigation facilities prevail. The cropping pattern can be practiced in clay loam to sandy loam soil. The technology can also be followed in the other high lands in pocket areas if irrigation facilities exist.

Benefits: Rice equivalent yield of the improved cropping pattern is 18.65 t/ha. The gross margin is 476% higher than the existing Fallow-Fallow-T. Aman cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 1.51.

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Fact sheet-12

Title of the technology : Intensive culture of Shing in pond

Introduction: Shing is a very popular fish in Bangladesh. This fish has less fat and high quality easily digestible protein. Therefore, its demand is high especially to the patients. Generally, fish farmer cultivate Shing in a semi-intensive manner. However, BFRI research results showed that intensive cultivation of Shing fish can be done easily and it is more profitable to the farmers with high production.

Description:

- In case of intensive culture of Shing, the area of pond should be within 0.20-0.50 acre
- In order to grow out this fish, the pond should be dried, and being applied with 20-30 g per dec. bleaching powder to eradicate the harmful microbes from the pond bottom. At this stage, the pond will be filled up with freshwater up to 1.5 m.
- Then, lime should be applied to the pond
- Only the healthy good quality female fingerling of Shing should be stocked @ 3500-4000/dec.
- Animal protein (32-35%) enriched supplementary feed should be applied @ 12-3% of body weight of fish in the evening and morning from the day of stocking of fingerlings.

Suitable location/ecosystem: Intensive cultivation of Shing can be done both in deep fresh water small and large ponds.

Benefits:

- Shing can be produced16.0-18.0 MT from 1.0 acre sized pond at 6-7 months by adopting above technology
- A total profit of Tk. 40-50 lacs can be earned by spending Tk. 250000-300000 acre^{-1} of pond.

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ii. Effectiveness in Policy Support

- Women empowerment will be ensured somehow through creating employment and income enhancement of women.
- Increasing cropping intensity and productivity through cultivation of intensive cropping pattern that will help to achieve the target under SDG goal-2 “By 2030, and double the agricultural productivity and incomes of small scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, through secure and equal access to land, other productivity resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment”.

H. Technology/Knowledge generation/Policy Support

i. Immediate impact on generated technology

- Increases vegetables, fruits and other crops production as well as farmers’ income.
- Creates employment opportunities for women and day labors.
- Clean the homestead environment through compost preparation with the wastage as well as green crop production.
- Increases production as well as farmers’ income.
- The average fish production from ponds in the FSRD site was 4700 kg/ha before the research

intervention. After intervention, production increased on average to 10000 kg among trial farmers in 5-8 months rearing, showing an increase in production of 112%. Of the fish production, 1.35% was consumed by the household and 98.65% was sold for cash.

- Before research intervention, contribution of fish culture to farm and house income was negligible being only 8%. After research intervention, the contribution of fish culture to farm and house hold income on average increase to 48%, indicating a six times increase as a result of incorporation of aquaculture into the farming system

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

- LSP: Local level production of seed/seedling in LSP nursery, poultry vaccination by LSP created an opportunity for employment. It will help for expansion of home gardening in future.
- Turkey rearing under semi-scavenging system will be suitable for homestead area.
- Pond based integrated farming will be helpful for sustainable production system.
- Cultivation technique of Turmeric, ginger and taro under perennial trees or house shade will be helpful to introduce them under fruit tree-based agroforestry system.
- Short duration high yielding Mustard variety will be accommodating to increase cropping intensity.
- Cultivation of high value and high yielding Tomato varieties will be helpful to increase total productivity.
- Cultivation of high yielding and late blight resistant Potato varieties will be helpful to increase system productivity:
- Proper management of fruit trees will help to increases production and income.
- Chewing type Sugarcane cultivation and seedling production at homestead level will give an opportunity at local level availability.
- Pigeon rearing will be suitable and profitable for homestead area.
- Location-wise homestead vegetables and fruits production model may be modified for more suitability and acceptance.
- Inclusion of mustard in Boro-Fallow-T. Aman cropping pattern can increase system productivity
- Cultivation of newly BRRI released rice varieties can increase system productivity
- High valued fish like as Pabda, Gulsha, Shing and Magur rearing under semi-intensive culture system
- Cultivation of vegetables (Bitter Gourd and Cucumber etc.) in medium high land instead of rice
- Inclusion of Aus in Boro-Fallow-T. Aman cropping pattern which can increase total farm productivity:
- Cultivation of newly BRRI released Aman rice varieties (BRRI dhan81, BRRI dhan87 and BRRI dhan88) which can increase farm productivity
- Vaccination and de-warming activities of cattle which can increase the weight and milk production as well prevent disease infestation
- Chicken, Duck and Pigeon rearing under semi-scavenging system can increase in come of house hold

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

- Year-round vegetables production in homestead area following 'Goyeshpur Model' for Pabna region; 'Modified Syedpur Model' for Rangpur region; 'Palima Model' for Tangail region; 'Modified Ishan Gopalpur Model' for Faridpur region; and 'Narekeli Model' for Sherpur region.

- Pond-based integrated farming.
- Fodder production in homestead or nearby homestead.
- Pigeon rearing at homestead level.
- Four crops based cropping pattern
- Semi-aquatic production system of vegetables, fish and fruit in mini pond
- Year round vegetables production in homestead following "Goyeshpur model" for Sreepur, Gazipur
- High valued fish species (Pabda, Gulsha, Shing and Magur) culture in seasonal ponds
- High value vegetables like as Bitter Gourd and Cucumber could be grown in the medium high land instead of rice at the Mymensing region.
- Summer Tomato could be grown in the open space or nearby homestead area of Fulpur, Mymensingh
- Year round vegetables could be production at homestead area of Fulpur upazilla of Mymensingh district

iv. Policy Support

Over the tested locations, it was found that the average vegetables production per homestead per year was 605 kg. In the contrary, there are about 14870576 numbers of farm household inthe rural areas of Bangladesh. If atleast 50% household can be brought under intensive vegetables cultivation following respective area-wise production model, it will help to produce a huge number of safe vegetables, which in turns will help to save the main land against vegetables production. The saved land from vegetables production can be used to produce the deficit crops like pulses, oilseeds etc., which will help to bring food security somehow in the country. From the above views, it is anticipated that full support may be given to produce safe and nutritious vegetables in homestead area of all over the country. For this regard, Local Service Provider (LSP) system may be developed for maintaining the input supply chain especially seed.

I. Information regarding Desk and field Monitoring

i. Desk Monitoring: Desk monitoring was done through the evalution of half yearly report & annual report

ii. Field monitoring

Field Monitoring of FSRD sites BARI

Table I.2.1.1 Field Monitoring at FSRD site Ajoddhapur, Rangpur

Sl. No.	Date	No of visit	Name and address of team visit	Output
01	11/02/2019	01	1. Dr. Shah Md. Ziqrul Haq Chowdhury Member Director (Livestock), BARC 2. Dr. Fauzia, Director TTMU, BARC 3. Mr. Hasan Hamidur Rahman, Director, Computer and GIS, BARC	Highlighted integrated approach especially composting.
02	18/03/2019	01	1 Dr. Abdus Salam, MD, BARC 2. Dr. A S M Mahabubur Rahaman Khan, Farming system Expart, P&E, BARC	Advised to farmers to use their resources intensively.
03	12/11/2019	01	Patrick Meyer, Mission Director, USAID Bangladesh	Advised to disseminate more area and appreciated the off-farm activities.
04	19/07/2019, 01/09/2019	02	Dr. A S M Mahabubur Rahaman Khan Farming system Expart, P&E, BARC	Fisheries and LSP activities were highlighted.
05	09/09/2019	01	1. Dr. Md. Kabir Uddin Ahmed CSO (Planning and Evaluation), BARC 2. Dr. A S M Mahabubur Rahaman Farming system Expart, P&E, BARC	Turkey rearing and off-farm activities were encouraged.

Sl. No.	Date	No of visit	Name and address of team visit	Output
06	19/01/2020	01	1. Dr. Md. Nowser Ali Sardar, Monitoring & Evaluation specialist, PIU-BARC, NATP-2 2. Mr. Abdur Rahman, NATP-2, BARC, Farmgate, Dhaka 3. Dipok Kumar, NATP-2, BARC, Farmgate, Dhaka	Farmers resources use pattern were highlighted.
07	25/02/2020, 16/0/2020 15/05/2020	03	Dr. A S M Mahabubur Rahaman Khan Farming system Expart, P&E, BARC	Home garden vegetables, fruits, fisheries and livestock activities were monitored.
08	26/02/2020	01	Morsheda Akhter, Deputy Secretary, Ministry of Agriculture	Visited FSRD work and advised to video documentation and planting a sapling in Dragon fruit orchard.
09	02/11/2019, 21/03/2020, 17/01/2021	03	1.Dr. M. Akkas Ali,CSO, OFRD, BARI 2. Dr Md. Faruk Hossain, SSO, OFRD, BARI	Field day and farmers discussion on integrated approach.
10	04/06/2021 17/11/2020	01	1.Dr. Quamrun Naher, SSO, OFRD, Gazipur 2. Dr. Md. Akhtar Hossain, SSO, OFRD, Gazipur	Vaccination of livestock and dissemination of home garden activities to neighbor farmers were observed.

Table I.2.1.2 Field Monitoring at FSRD site, Ganggarampur, Pabna

Sl. No.	Date	No. of visit	Name and addresses of team visit	Output
01	27.01.2019	01	i. Dr. A S M Mahbubur Rahman Khan Farming Systems Expert, FSRD Project BARC, Farmgate, Dhaka ii. Dr. Kabir Uddin Ahmed, CSO, Planning and Evaluation Division, BARC, Farmgate, Dhaka	The team sharing opinion with farmers and BARI FSRD team and provided valuable suggestions for further improvement of FSRD activities.
02	25.02.2020	01	i Dr. Md. Rois Uddin, Director Pulse Research Center and Regional Agricultural Research Station BARI, Ishurdi, Pabna ii. Dr. Md. Mazharul Anwar Principal Scientific Officer On-Farm Research Division, Region-1 BARI, Shyampur, Rajshahi iii. Dr. Md. Altaf Hossain Rahman Principal Scientific Officer Pulse Research Center and Regional Agricultural Research Station BARI, Ishurdi, Pabna	The team sharing opinion with farmers and BARI FSRD team and provided valuable suggestions regarding nutrition aspects of different pulse crops and pest management for integrated farming.

Sl. No.	Date	No. of visit	Name and addresses of team visit	Output
	27.02.2020		I. Dr. M. Akkas Ali Chief Scientific Officer On-Farm Research Division BARI, Joydebpur, Gazipur II. Dr. Jagadish Chandra Barman Principal Scientific Officer OFRD, Barind Station, Rajshahi III. Dr. Md. Akter Hossain Senior Scientific Officer OFRD, BARI, Joydebpur, Gazipur IV. Dr. Md. Faruque Hossain Senior Scientific Officer OFRD, BARI, Joydebpur, Gazipur	The team sharing opinion with farmers and BARI FSRD team and provided valuable suggestions for dissemination of viable IF technologies and making the site as learning centre of IF technologies.

Table I.2.1.3. Field Monitoring at FSRD Site, Sholakundu, Faridpur

Sl. No.	Date	No. of visit	Name and address of team visit	Output
01	14 January 2019	01	1.Dr. Quamrun Naher, SSO, OFRD, Gazipur 2. Dr. Md. Akhtar Hossain SSO, OFRD, Gazipur	Homestead and field crop
02	12 July 2019	01	1.Dr. A S M Mahabubur Rhaman Khan Farming Systems Expert, FSRD Project, BARC, Dhaka 2. Dr. Subhash Chandra Sarker SSO, FSRD Project, BARC, Dhaka	,,
03	19 February 2020	01	1. Dr. Muhammad. Shamsul Alom CSO, RARS, Barisal 2. Dr. Md. Saleh Uddin, CSO, RPRS, Madaripur	,,
04	25 June 2020	01	1. Md. Habibur Rahaman Sheak Director (SS), BARI, Gazipur 2. Md. Rifatul Hossain, AD, DAE, Faridpur	Sapling distribution
05	30 August 2020	01	1 Dr. Md. Miaruddin, Director (Research), BARI 2. Md. Rifatul Hossain, AD, DAE, Faridpur 3. Dr. Muhammad. Shamsul Alom CSO, RARS, Barisal	Training
06	07 October 2020	01	1.Dr. Md. Saleh Uddin, CSO, RPRS, Madaripur 2.Dr. Md. Hazrot Ali, DD, DAE, Faridpur	Homestead and field crop
07	11 October 2020	01	1. Dr. Md. Nazirul Islam, DG, BARI, Gazipur 2. Md. Rifatul Hossain, AD, DAE, Faridpur 3. Dr. Md. Hamim Reza, CSO, SRC, Bogura 4. Md. Rafi Uddin, CSO, RARS, Barisal	Training

Table I.2.1.4. Field Monitoring at FSRD Site, Atia, Tangail

Sl. No.	Date	No. of visit	Name and addresses of team visit	Output
01	27.01.2019	01	1. Dr. A S M Mahbubur Rahman Khan Farming Systems Expert, P&E, BARC, Farmga Dhaka 2. Dr. Mian Sayeed Hassan, Director PIU-BARC, NATP-2 Project, BARC, Farmgate, Dhaka 3. Dr. Kabir Uddin Ahmed CSO, P & E Division, BARC, Farmgate, Dhaka	By monitoring, farmers become aware of achievements as well as motivated to implement integrated holistic approach
02	16.11.2020	01	1. Dr. Quamrun Naher SSO and PI Plainland Project On-Farm Research Division BARI, Joydebpur, Gazipur 2. Dr. Md. Akter Hossain Senior Scientific Officer On-Farm Research Division BARI, Joydebpur, Gazipur	Farmers gathered knowledge about integrated farming activities for better maintenance of their life

Table I.2.1.5. Field Monitoring at FSRD Site, Tarakandi, Sherpur

Sl. No.	Date	No. of visit	Name and addresses of team visit	Output
01	16.09.2018	01	Dr. Apurbo Kanti Chowdhury CSO, RARS, Jamalpur	Fayoumi breed distribution among the farmers at FSRD site
02	03.11.2018	01	Dr. A S M Mahbubur Rahman Khan CSO, On-Farm Research Division, BARI, Joydebpur, Gazipur Dr. Apurbo Kanti Chowdhury CSO, RARS, Jamalpur	By monitoring, farmers become aware of achievements as well as motivated to implement integrated approach
03	23.12.2018	01	Md Ashraf Uddin DD, DAE, Sherpur	Farmers gathered knowledge about integrated farming activities for better maintenance of their life
04	09.11.2019	01	Dr. Abul Kalam Azad DG, BARI, Joydebpur, Gazipur	Visit FSRD work and advised to the farmers for better management
05	07.02.2020	01	Md. Atiur Rahman Atik MP, Whip Bangladesh Parliament Dr. Md. Abdul Wahab DG, BARI, Joydebpur, Gazipur Dr. Md. Nazirul Islam Director, Planning and Evaluation Wing BARI, Joydebpur, Gazipur Dr. M. Akkas Ali CSO, On-Farm Research Division, BARI, Joydebpur, Gazipur	Appreciate the FSRD activities and advise to continue this program

Sl. No.	Date	No. of visit	Name and addresses of team visit	Output
06	02.03.2020	01	Dr. Md. Tariqul Islam CSO, RARS, Jamalpur	Field visit and motivated to the farmers
07	21.08.2020	01	Dr. Md. Nazirul Islam DG, BARI, Joydebpur, Gazipur Dr. Md. Shahiduzzaman CSO, RSRC, BARI, Joydebpur, Gazipur	Different type of saplings distributed among the Farmers at FSRD site and gathered knowledge about integrated farming activities for better maintenance of their life
08	01.01.2021	01	Dr. Md. Abdus Salam, Member Director, Planning and Evaluation Division, BARC, Farmgate, Dhaka Dr. Kabir Uddin Ahmed CSO, P and E Division, BARC, Farmgate, Dhaka Dr.A S M Mahbubur Rahman Khan Farming Systems Expert, P&E, BARC, Dhaka	By monitoring, farmers become aware of achievements as well as motivated to implement integrated holistic approach

Field monitoring of BRRI Component

Table I.2.2.1. Field Monitoring at FSRD site Tengra of BRRI

Sl. No.	Date	No. of visit	Name and addresses of team visit	Output
01	28.11.2018	01	Dr. Md. Shahjahan Kabir DG, BRRI, Gazipur	Training and farmers gathering was organized at FSRD site, visited different activities of the project
02	30.04.2019	01	Dr. Mian Sayeed Hasan Director, NATP-2, BARC and World Bank Team	Farmers gathered knowledge about integrated farming activities for better maintenance of their life
03	11.05.2019	01	Dr. Md. Aziz Zilany Chowdhury Member Director, BARC, Dhaka Dr. Md. Harunur Rashid CSO, BARC, Dhaka	By monitoring, farmers become aware of achievements as well as motivated to implement integrated farming system approach
04	12.09.2020	01	Dr. Md. Abdus Salam, MD (P&E) and Coordinator, FSRD Plainland, Ecosystem, BARC Dr.A S M Mahbubur Rahman Khan Farming Systems Expert, P&E, BARC, Dhaka	Visited FSRD activities and advised to the farmers in different aspects for better management.

Field monitoring of BFRI Component

Table I.2.3.1. Field Monitoring at FSRD site Mokamia of BFRI

Sl. No.	Date	No. of visit	Name and addresses of team visit	Output
01	15.08.2018	01	Dr. M.A. Awal CSO and Co-Coordinator Plain land Ecosystem, BARC	• Observed fish growth of different ponds FSRD farmers • Observed vegetable field & rice field of FSRD farmers • Observed Khiky Camble duck & pigeon of FSRD farmers • Given proper advise to the farmers for better management
02	12.02.2019	01	Dr. S.M. Boktiar, Coordinator, Plain land Ecosystem Dr.A S M Mahbubur Rahman Khan Farming Systems Expert, FSRD Project, BARC, Dhaka Dr. Kabir Ahmed, CSO & Co-Coordinator Plain land Ecosystem BARC	• Observed fish growth of different ponds FSRD farmers • Observed vegetable field & rice field of FSRD farmers • Observed Khiky camble duck & pigeon of FSRD farmers • Attended in the farmers day and given proper advise to the farmers for better management
03	16.09.2020	01	Dr. S.M. Boktiar, Coordinator, Plain land Ecosystem Dr.A S M Mahbubur Rahman Khan Farming Systems Expert, FSRD Project, BARC, Dhaka Dr. Kabir Ahmed, PSO & Co-Coordinator Plain land Ecosystem BARC	Attended in the farmers day and BTV Mati-O-Manush programme
04	25.07.2020	01	Dr. M.A. Salam, Coordinator Plain land Ecosystem Dr. A S M Mahbubur Rahman Khan Farming Systems Expert, FSRD Project, BARC, Dhaka Dr. Kabir Ahmed, CSO & Co-Coordinator Plain land Ecosystem BARC	Observed the overall progress of FSRD activities of BFRI component at FSRD village, Mokamia
05	27.10.2020	01	Dr. Yahia Mahmud DG, BFRI, Mymensingh	• Visit FSRD activities of Crop, Fishery and Livestock component • Delivered proper advised to the farmers for better management.

iii. Weather data, Flood/salinity/drought level (if applicable) and natural calamities

BARI Component:

FSRD Site, Ajoddhapur, Rangpur

Flood: Continuous rainfall in September 2020 and Severe flood occurred during late September 2020.

Table I.3.1.1. Weather data of FSRD Site, Ajoddhapur, Rangpur Rangpur during 2018 to 2020.

Month	Temperature (°C)						Avg. RH (%)			Total rainfall (mm)		
	Avg. Max			Avg. Min								
	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020
February	26.77	26.35	26.08	14.16	14.45	12.93	69.59	70.82	70.59	0	119.60	0
March	30.99	30.14	30.09	18.98	17.56	17.94	6579	64.23	68.45	13.40	11.0	31.10
April	30.60	30.89	31.42	21.67	21.70	20.60	75.10	73.25	70.82	152.20	140.0	190.0
May	31.17	32.05	31.45	22.98	23.31	23.15	77.45	77.12	79.35	324.50	346.30	347.40
June	33.35	33.74	32.94	25.82	25.53	25.96	79.63	90.33	81.83	321.40	277.50	389.70
July	33.26	32.44	32	27.14	26.41	16.14	79.92	83.03	84.69	143.20	595.60	748.80
August	33.60	34.25	34.12	27.02	27.36	27.12	79.29	78.53	78.90	207.30	336.20	182.50
September	32.99	31.59	31.15	26.08	25.79	26.08	79.52	85.45	85.82	147.70	604.80	1036.60
October	30.80	30.53	33.10	22.30	23.15	24.80	77.02	79.76	78.03	32.30	174.40	119.0
November	29.25	29.44	29.48	17.38	19.51	17.93	71.07	74.87	68.72	0	0	0
December	25.68	23.55	25.08	12.62	12.71	14.34	70.26	75.84	75.72	7.6	0	0
January	25.69	22.50	-	11.79	11.92	-	66.85	77.26	-	0	8	-

FSRD Site, Ganggarampur, Pabna

Table I.3.1.2. Weather data of FSRD Site, Ganggarampur, Pabna during 2018 to 2020

Month	Temperature (°C)						Avg. RH (%)			Total rainfall (mm)		
	Avg. Max			Avg. Min								
	2018	2019	2020	2018	2019	2020	2018	2019	2020	2018	2019	2020
January	17.80	25.60	23.20	12.80	10.50	11.29	76.10	81.70	100.50	00.00	0.00	21.30
February	20.20	33.40	26.40	16.80	26.80	26.00	73.50	79.30	80.60	00.00	276.10	0.00
March	20.20	32.20	31.40	16.90	17.80	17.80	69.90	70.90	75.30	168.40	00.00	0.00
April	31.80	34.10	34.20	20.90	22.90	21.70	81.40	79.80	81.30	212.30	00.00	13.20
May	32.00	35.70	33.60	24.60	25.70	24.10	79.90	79.00	81.80	144.50	1251.00	372
June	34.03	34.90	34.85	25.81	26.20	26.00	79.40	84.20	82.73	214.40	1679.00	-
July	33.99	34.00	34.10	27.36	26.60	26.74	80.60	86.80	84.94	540.50	297.10	-
August	33.44	33.90	33.92	26.85	26.80	26.82	82.70	86.20	82.74	356.50	158.5	-
September	33.54	32.70	33.24	25.99	26.30	26.00	81.70	88.90	83.70	270.50	192.9	-
October	31.45	31.40	31.44	22.80	22.90	22.12	80.70	91.90	85.72	75.80	191.2	-
November	28.80	29.70	29.60	18.20	18.50	18.60	82.50	90.80	76.73	2.60	69.1	-
December	25.0	24.2	24.52	13.2	19.8	18.20	71.3	89.8	62.50	7.2	6.0	-

FSRD Site, Sholakundu, Faridpur

Table I.3.1.3. Weather data of FSRD Site, Sholakundu, Faridpur during 2018 to 2020

Month	Temperature (°C)						Avg. RH (%)			Total rainfall (mm)		
	Avg. Max			Avg. Min								
	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020
February	29.54	28.18	27.13	15.82	14.59	13.67	73.5	76.18	71.86	3.7	94.3	1.40
March	34.87	31.94	32.47	21.17	19.64	19.27	70.93	70.61	64.61	5.1	10.0	30.90
April	33.18	34.25	34.14	22.11	22.95	22.67	77.20	76.23	72.30	222.1	70.9	101.60
May	32.63	34.97	32.15	23.88	25.33	22.91	82.96	78.70	80.29	219.1	162	311.50
June	33.87	34.14	33.11	25.91	25.73	26.5	84.23	82.26	84.36	221.4	105	239.30
July	32.67	33.55	32.90	26.18	25.99	26.90	86.03	85.68	85.90	419.2	283.3	355.2
August	33.13	33.48	32.67	26.55	26.06	27.09	83.83	84.10	84.68	81.9	220.8	202
September	33.72	33.04	33.31	26.02	25.54	27.13	83.9	81.36	85	144.2	118.7	229.8

Month	Temperature (°C)						Avg. RH (%)			Total rainfall (mm)		
	Avg. Max			Avg. Min								
	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020
October	32.00	32.38	33.15	22.75	22.98	26.07	81.00	84.68	83.74	68.5	112.9	96.7
November	30.28	30.53	30.55	18.09	19.70	19.57	78.7	81.43	77.77	21.8	39.3	31.2
December	25.88	24.94	--	13.72	14.02	--	77.61	82.26	--	13.3	8.8	--
January	26.64	23.89	--	11.82	12.05	--	73.71	80.16	--	000.0	23.6	--

FSRD Site, Atia Tangail

Table I.3.1.4. Weather data of FSRD Site, Atia Tangail during 2018 to 2020

Month	Temperature (°C)						Avg. RH (%)			Total rainfall (mm)		
	Avg. Max			Avg. Min								
	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020
February	28.61	28.09	26.26	15.53	14.73	13.29	73.46	71.71	74.25	40.00	73.60	01.00
March	32.80	31.26	31.51	20.12	19.10	18.47	70.55	67.52	66.80	41.00	99.70	44.60
April	31.98	33.18	33.13	21.82	22.37	21.48	93.50	74.70	74.77	382.00	281.20	273.30
May	31.95	34.79	32.93	23.16	24.36	23.09	80.77	77.13	79.00	402.10	360.30	350.40
June	34.03	34.13	33.57	25.81	25.32	25.45	79.40	80.8 0	82.73	214.40	312.40	303.40
July	33.99	33.38	33.12	27.36	25.74	25.84	80.61	82.74	84.94	540.50	576.10	459.60
August	33.44	34.13	33.86	26.85	26.68	25. 98	82.68	79.00	82.74	356.50	200.10	264.60
September	33.54	33.07	33.75	25.99	25.71	25.28	81.69	82.90	83.70	270.50	254.30	215.30
October	31.45	31.99	33.10	22.80	23.10	24.96	80.68	82.00	85.72	75.80	163.60	166.80
November	29.84	29.92	30.60	17.89	19.22	17.03	76.83	82.00	76.73	46.00	19.50	00.00
December	25.63	24.31	18.58	13.29	13.51	10.08	78.35	85.30	62.50	22.80	10.00	00.00
January	26.31	23.15	-	11.57	11.87	-	74.71	83.58	-	00.00	44.30	-

FSRD Site, Tarakandi, Sherpur

Table I.3.1.5. Weather data of FSRD Site, Tarakandi, Sherpur during 2018 to 2020

Month	Temperature (°C)						Avg. RH (%)			Total rainfall (mm)		
	Avg. Max			Avg. Min								
	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020	2018-19	2019-20	2020
February	16.00	17.03	17.34	24.60	26.28	25.41	0.85	2.53	0.1	24	71	3
March	19.51	20.48	12.00	28.83	29.41	31.29	7.11	3.58	1.96	220.50	111	61
April	30.03	23.23	23.5	30.22	29.46	32.80	19.38	20.60	13.70	601	616	411
May	25.12	26.61	26.93	26.19	33.12	30.96	74.8	36.77	56.45	2318.8	1140	1750
June	28.90	28.43	29.60	21.86	32.56	30.86	16.38	34.67	53.93	491.5	1040.50	1618
July	29.54	27.67	28.64	30.90	31.67	29.8	33.16	69.58	81.58	1028	2157	2529
August	25.70	29.09	29.22	34.48	33.38	34.83	37.06	24.97	19.12	1149	774	593
September	5.76	27.56	28.10	30.00	31.56	32.26	32.90	33.3	67.33	987	999	2020
October	25.64	25.54	28.35	29.09	30.29	34.25	6.25	32.58	24.12	194	1010	748
November	20.10	24.30	22.03	27.20	28.96	29.58	0.5	2.06	00	17	62	00
December	15.93	16.64	14.78	24.38	22.12	25	1.87	0	00	58	0	00
January	15.32	0	0	26.06	0	0	0	1.12	0	0	35	0

BRRI Component:

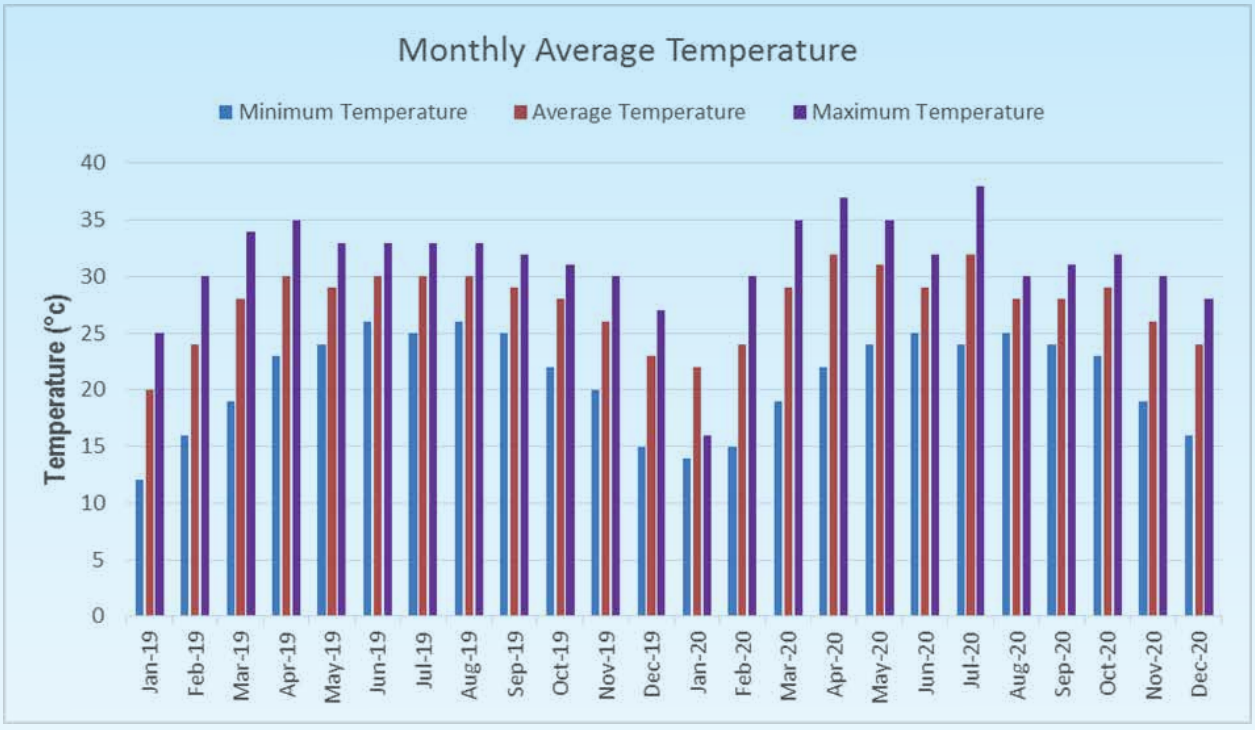

Figure I.1. Monthly average temperature at FSR&D site, Tengra, Sreepur, Gazipur during January 2019 - December 2020

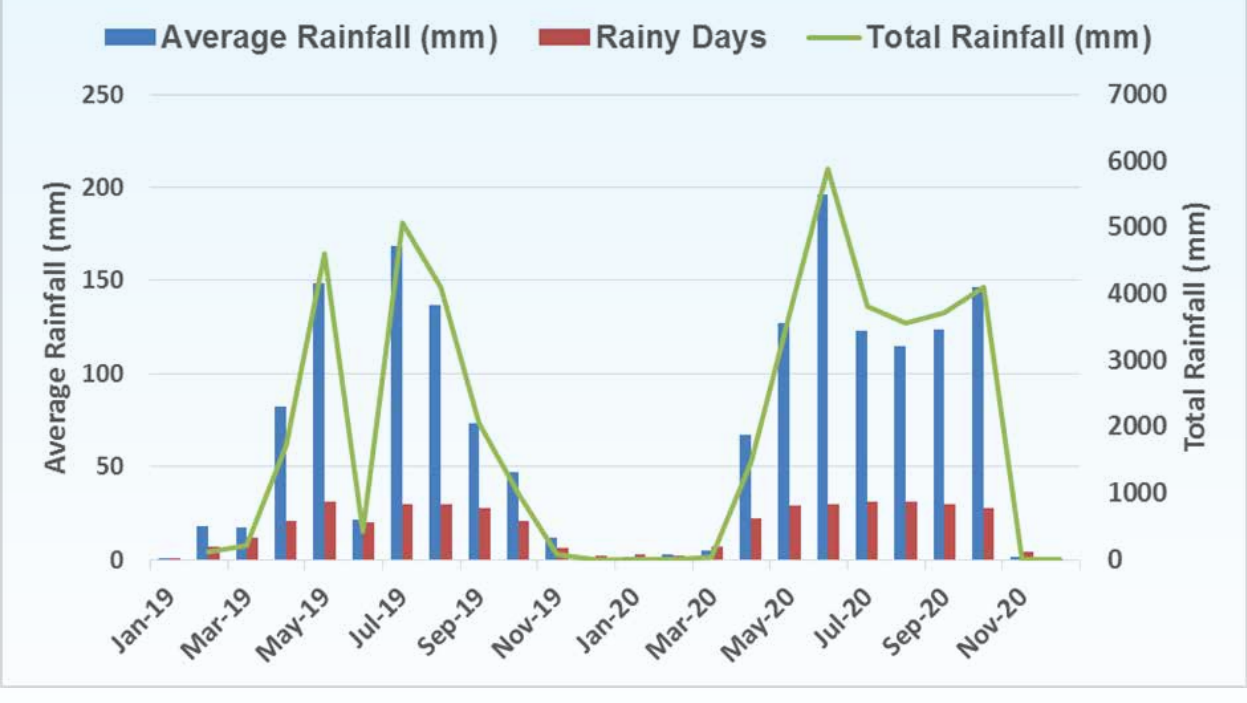

Figure I-2. Monthly average rainfall data at FSR&D site, Tengra, Sreepur, Gazipur during January 2019 - December 2020

J. Sub-project auditing (covers all types of audit performed)

Table J.1 Sub-project audit information of BARC, BARI, BRRI and BFRI component

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
BARC Component				
GoB		42,69,000		
GoB	No observation raised in 1st, 2nd and 3rd financial year.	13374040	31 October 2021	Satisfactory
FAPAD (GoB)	No objection raised in first financial year. In second financial year objection was raised on vat payment for furniture (12.5% of TK.1.3 lac). No objection raised in third financial year.	5653842	Till June 2021	Satisfactory
FAPAD (GoB)	No audit objection raised in first, second and third financial year.	6630699	Till February 2021	Satisfactory

K. Lessons Learned

- There is plenty scope to utilize the rural farm household all over the country to produce vegetables and fruits and increase farm income.
- Home gardening with vegetables and fruits will lessen the pressure on mainland.
- Inclusion of proper variety, quality seed and improved crop management can enhance cropping intensity and productivity compare to existing cropping practice.
- Soil health need to be improved by inclusion of pulses crop in the existing cropping pattern.
- Proper utilization of farm resources could help income enhancement compared to existing condition.
- Appropriate crop management can produce better yield than their existing cropping practice
- Changed in consumption habit with vegetables and fruits due to availability of diversified vegetables and fruits round the year and it also influence the nutritional status of the rural people.
- Turkey should be reared in semi scavenging system to protect the homestead vegetables.
- Incase of pigeon rearing, supplimetery feed should be propvited regularly to tame.
- Regular vaccine should be applied at early in the morning to poultry birds and livestock for more success.
- Proper management of compost pit and its utilization can help to produce safe and nutritious vegetables.
- Water needs to supplement in seasonal pond during dry season for optimum growth of fish.
- There is wide scope to utilize the homestead pond to increase family income as well as meet-up family nutrition
- If female farmers involved in the farming activities, profit margin was higher
- HYV seed and good quality fingerlings has positive impact on production of crops and fishes
- Farmers training as well as result demonstration activities have positive impact on technology dissemination

L. Challenges

- Uneven rainfall/heavy rainfall/flood.
- Short term and irregular funding hamper the smoothness of the program.
- Shortage of skilled manpower especially in livestock, fisheries and Agril. Economic component.
- Lack of strong multidisciplinary scientific team like fisheries and livestock to implement the program.
- Lack of proper agricultural knowledge of farmer.
- Lack of proper machineries and spare parts for mechanization.
- Lack of climate change resilient technology
- Lack of small-scale irrigation facilities.
- Lack of seed production and storage facilities of huge number of vegetables.
- Homestead activities hampered sometimes due to dense vegetation.
- Seasonal pond hampering the fish production.
- Unstable market price of the inputs and outputs.
- Lack of proper data analysis software.
- Lack knowledge on production of high valued fish in seasonal and perinnual pond
- Safe vegetables production without using chemical pesticide
- Lack knowledge on production of HYV Aus in Kharif-1 season in Mymenshing region
- Lack of proper knowledge production of vegetables in rice field for getting more profit
- Lack of proper knowledge on modern of agricultural technology.
- Training on different components of the farmers was insufficient

M. Suggestions for future planning

- Local Service Provider (LSP) needs to establish at each location for sustainable seed/seedling exchange system.
- Provision of long-term support to a greater number of farm household will help for continuing home gardening.
- Multidisciplinary team including crop scientist, livestock scientist, fisheries scientist and economist should be involved at each research site for more effective research.
- Funding should be reasonable, timeliness and long term.
- Well compost pit should be mandatory for each farm household.
- Mini solar pump needs to include in the home garden program.
- Mechanization needs to give emphasis for crop production.
- Marketing channel needs to develop for ensuring maximum price of farmers product.
- Soil health needs to address in case of intensive cropping system.
- Integrated farming approach should be given priority for the development of livelihood of farmers.
- Farmers capacity on agricultural technologies needs to develop through hands on training.
- Farming system should be digitalized through Data Driven Decision Making Tools (Models), crop monitoring tools through GIS (Geological Information System) and IoT (Internet of Things), Integration options way out through ML (Machine learning), DL (Deep Learning) and ANN (Artificial Nural Network) in cloud computing platform.
- Intensive and diversified cropping is possible so activities regarding cropping system intensification can be taken to increase production.
- Activities need to be taken regarding agricultural mechanization and improvement of soil health.
- Irrigation facility development is also a prime need for the intensification of cropping in the region
- Agricultural knowledge of farmers need to be develop through hands on training and need to make them aware about different agricultural technologies that will improve their productivity as well as income.
- Farming system research projects should be continued for at least five years to get better findings.
- Farming system research and development (FSRD) activities may be strengthened throughout the country
- Success stories of FSRD sites may be disseminated through mass media, conferences, seminars and trainings etc.

- Newly evolved technologies may be disseminated in the Farming system research and development sites for rapid dissemination in future
- Intensive and diversified cropping system can be taken to the farmers to increase production.
- Several traning on different components are required to facilitate the improvrmrnt of the skill of the farmers.
- Strong linkage should be developed among the NARS, DAE, DLS and DoF for dissemination of technologies.

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Signature of the Coordinator

Date …….

Seal

Counter signature of the Head of the organization/authorized representative

Date ……..

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