



Program Based Research Grant (PBRG)



Sub-project Completion Report on Climate Resilient Farming Systems Research & Development for the Coastal Ecosystem

February 2018 to January 2022

Coordinating Organization

Planning & Evaluation Division

Bangladesh Agricultural Research Council

Farmgate, Dhaka-1215



BANGLADESH AGRICULTURAL RESEARCH COUNCIL

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Sub-project Completion Report
on
Climate Resilient Farming Systems Research and
Development for the Coastal Ecosystem

Implementing Organization



On-Farm Research Division
Bangladesh Agricultural Research Institute



Rice Farming Systems Division
Bangladesh Rice Research Institute



Agronomy Division
Bangladesh Institute of Nuclear Agriculture

Project Implementation Unit
National Agricultural Technology Program-Phase II Project
Bangladesh Agricultural Research Council
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Abbreviation and Acronyms

°C	:	Degree Centigrade
AEZ	:	Agro Ecological Zone
AO	:	Agriculture Officer
Av.	:	Average
B	:	Boron
BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agricultural Research Institute
BRRI	:	Bangladesh Rice Research Institute
BAU	:	Bangladesh Agricultural University
BCR	:	Benefit Cost Ratio
BCRDV	:	Baby Chick Ranikhet Disease Vaccine
BINA	:	Bangladesh Institute of Nuclear Agriculture
BMD	:	Bangladesh Meteorological Division
BWDB	:	Bangladesh Water Development Board
CC	:	Component Crop
CDSP	:	Char Development and Settlement Project
CDSP IV	:	Char Development and Settlement Project Phase IV
Co-PI	:	Co-Principal Investigator
cm	:	Centimeter
CP	:	Cropping Pattern
CSO	:	Chief Scientific Officer
DAE	:	Department of Agricultural Extension
DD	:	Deputy Director
DLS	:	Department of Livestock Services
DLO	:	District Livestock Officer
DAS	:	Days after Sowing
DUS	:	Deep Unnayan Sangstha
Dec	:	Decimal
dS/m	:	Decisiemens per meter
E	:	East
EC _e	:	Electric Conductivity
F.	:	Fallow
FRG	:	Fertilizer Recommendation Guide
FSR	:	Farming Systems Research
FSRD	:	Farming System Research and Development
FSRDP	:	Farming System Research and Development program
g	:	Gram
GR	:	Gross Return
GM	:	Gross Margin
GMC	:	Green Manuring Crops
HL	:	High land
HYV	:	High Yielding Variety

ha	:	Hectare
IPM	:	Integrated Pest Management
IPNS	:	Integrated Plant Nutrition System
K	:	Potash
Kg	:	Kilogram
Km	:	Kilometer
LSP	:	Local Service Provider
LER	:	Land Equivalent Ratio
MBCR	:	Marginal Benefit Cost Ratio
MC	:	Main Crop
MHL	:	Medium high land
MLL	:	Medium low land
mm	:	Millimeter
MoP	:	Muriate of Potash
NATP	:	National Agricultural Technology Project
NARS	:	National Agricultural Research System
N	:	North
N	:	Nitrogen
NGOs	:	Non-Government Organization
OFRD	:	On-Farm Research Division
ORC	:	Oilseeds Research Center
PIU	:	Project Implementation Unit
PBRG	:	Programme Based Research Grant
PPR	:	Peste Des Petits Runinants
P	:	Phosphorus
PA	:	Preference Analysis
PBD	:	Plant Breeding Division
PI	:	Principal Investigator
PRA	:	Participatory Rural Appraisal
PSO	:	Principal Scientific Officer
PVS	:	Participatory Variety Selection
REY	:	Rice Equivalent Yield
R. Grass pea	:	Relay Grass pea
RCBD	:	Randomized Complete Block Design
RPVS	:	Researcher-led Participatory Variety Section
SDG	:	Sustainable Development Goal
S	:	Sulphur
SA	:	Scientific Assistant
SAAO	:	Sub Assistant Agricultural Officer
SO	:	Scientific Officer
SRDI	:	Soil Resources Development Institute
SSO	:	Senior Scientific Officer
SEY	:	Sugarcane Equivalent Yield
SSUS	:	Sagarika Samaj Unnayan Sangstha

t/ha, t ha ⁻¹	:	Ton per hectare
T. Aman	:	Transplanted Aman rice
TDS	:	Total Dissolved Solids
Temp.	:	Temperature
TSP	:	Triple Super Phosphate
TVC	:	Total Variable Cost
Tk	:	Taka
UAO	:	Upazila Agriculture Officer
ULO	:	Upazila Livestock Officer
USA	:	United State of America
VC	:	Vermicompost
VLL	:	Very low land
WAPDA	:	Water and Power Development Authority
WP	:	Wetable Powder
WPGM	:	Whole Pattern Gross Margin
WPREY	:	Whole Pattern Rice Equivalent Yield
Zn	:	Zinc

Table of Contents

Sl. No.	Subject	Page No.
	List of Tables	xx
	List of Figure	xxxii
	List of Picture	xxxiii
	Executive Summary	xxxvi
A.	Sub-project Description	
1.	Title of the PBRG sub-project	1
2.	Implementating Organization (s)	1
3.	Name and full address with phone, cell and Co-ordinator E-mail of PI/Co-PI	1
4.	Sub-project budget (Tk.)	1
	4.1. Total (in Tk.as aapproved)	1
	4.2. Latest Revised	1
5.	Duration of the sub -project	1
	5.1. Start date (based on LoA signed)	1
	5.2. End date	1
6.	Background of the sub-project	2
7.	Sub-project general objectives	2
8.	Sub-project specific objectives	2
9.	Implementating locations	3
10.	Methodology in brief	4
10.1	Year-round vegetables and fruit production in homestead	6
10.1.1	Modified Atkapalia model (BARI, Noakhali)	6
10.1.2	Modified Lebukhali Model (BARI, Patuakhali)	7
10.1.3	Modified Laudove Model (BRRRI, Shatkhira)	8
10.1.4	Modified Laudove Model (BINA, Shatkhira)	9
10.1.5	Summer Tomato Production in the highlands adjacent to homestead at FSRD site: Subarnachar, Noakhali (BARI)	10
10.1.6	Winter vegetables cultivation under the shade of summer tomato adjacent areas of homestead at FSRD Site: Subarnachar, Noakhali (BARI)	10
10.1.7	Vegetables production nearby homestead at FSRD site: Jamla, Patuakhali (BARI)	11

Sl. No.	Subject	Page No.
10.1.8	Vegetables Cultivation on Raised Bed System	12
10.1.9	Year-round vegetables production nearby homestead area at Kaliganj, Satkhira (BRRRI) FSRD Site	13
10.1.10	Spice's production in the unused shady places of homesteads at FSRD Site: Kaliganj, Satkhira (BRRRI)	13
10.1.11	High value vegetables production nearby homestead at FSRD site: Shyamnagar, Satkhira (BINA)	13
10.1.12	Establishment of mini mixed fruit orchard of Mango, Litchi and Ber in homestead at FSRD Site: Kaliganj, Satkhira (BRRRI)	14
10.1.13	Development of mini orchard in homestead at FSRD Site: Shyamnagar, Satkhira (BINA)	14
10.2	Improvement or development of cropping pattern under coastal ecosystem	14
10.3	On-farm verification trial at coastal ecosystem	21
10.3.1	On-Farm Verification Trials on different <i>Rabi</i> crops at Farmers field in FSRD sites under Coastal Ecosystem	24
10.4	Intercropping system at coastal ecosystem	24
10.4.1	Intercropping system at FSRD site: Subarnachar, Noakhali under Coastal Ecosystem during 2018-2020 (BARI)	24
10.4.2	Intercropping systems in Sugarcane at FSRD Site: Kaliganj, Satkhira (BRRRI)	25
10.5.1	Integrated Plant Nutrition System (IPNS) and Integrated Pest Management (IPM) approaches in Watermelon cultivation at FSRD site, Noakhali (BARI)	26
10.5.2	Participatory Variety Selection (PVS) of Aus Rice at FSRD site: Subarnachar, Noakhali (BARI)	26
10.6	Production program at different FSRD sites under coastal ecosystem during, 2018 to 2020	27
10.6.1	Production Program of Aus Rice at FSRD Site : Jamla, Patuakhali (BARI)	27
10.6.2	Production program of T. Aman varieties at FSRD Sites: Noakhali and Patuakhali (BARI)	27

Sl. No.	Subject	Page No.
10.6.3	Quality seed production of Soybean in <i>Kharif II</i> season at FSRD Site: Subarnachar, Noakhali (BARI)	28
10.6.4	Production program of BRRI released T. Aman and Boro rice varieties at FSRD Site: Kaliganj, Satkhira (BRRI)	29
10.6.5	Production program of different high yielding crops varieties: Rice, Mustard and Grasspea (BINA)	29
10.7	Improvement of productivity in gher system at FSRD Site: Kaliganj, Satkhira (BRRI)	29
10.8	Movable seedbed for winter vegetables seedlings production in the highlands adjacent to homestead at FSRD Site: Subarnachar, Noakhali (BARI)	30
11.	Results and discussion	33
11.1	Homestead Production System	33
11.1.1	Year-round vegetables and fruits production in homestead at FSRD Site: Subarnachar, Noakhali (BARI)	33
11.1.2	Year-round vegetables and fruit production at FSRD Site: Jamla, Patuakhali (BARI)	39
11.1.3	Year-round vegetables production in homestead at FSRD Site: Kaliganj, Satkhira (BRRI)	43
11.1.4	Year round vegetables production in the homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)	45
11.1.5	Summer Tomato Production in the highlands adjacent to homestead at FSRD Site: Subarnachar, Noakhali (BARI)	47
11.1.6	Vegetables cultivation adjacent to homestead at FSRD Site: Subarnachar, Noakhali (BARI)	48
11.1.7	Year-round vegetables production at nearby homestead area at FSRD Site : Kaliganj, Satkhira (BRRI)	49
11.1.8	High value vegetables production nearby the homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)	51
11.1.9	Vegetables production in Sorjan bed and raised bed at FSRD Site: Jamla, Patuakhali (BARI)	52

Sl. No.	Subject	Page No.
11.1.10	Spice's production in unused shady places of the homestead area at FSRD Site: Kaliganj, Satkhira (BRRI)	53
11.1.11	Establishment of mini orchard in the backside of the homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)	55
11.1.12	Plantation and management of existing fruit trees in homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)	55
11.1.13	Movable seedbed for winter vegetables seedlings production at FSRD Site: Subarnachar, Noakhali (BARI)	56
11.1.14	Family Labour utilization	57
11.2	Crops and cropping system	58
11.2.1	Improvement of existing cropping pattern at FSRD site: Subarnachar Noakhali (BARI)	58
11.2.2	Improvement of the existing Soybean-Fallow-T. Aman cropping pattern through inclusion of modern soybean varieties and Aus rice.	59
11.2.3	Improvement of the existing Fallow- Fallow - T. Aman (BR23) cropping pattern through inclusion of underutilized cereal crop and green manuring crop.	60
11.2.4	Development of Potato-Mungbean-T. Aman cropping pattern against Mungbean-Fallow-T. Aman cropping pattern at FSRD Site: Jamla, Patuakhali (BARI)	61
11.2.5	Development of Sunflower-T. Aus-T. Aman cropping pattern against Grasspea - Fallow-T. Aman cropping pattern at FSRD Site: Jamla, Patuakhali (BARI)	62
11.2.6	Improvement of existing Boro-Fallow-T. Aman cropping pattern at FSRD Site: Kaliganj, Satkhira (BRRI)	63
11.2.7	Improvement of existing Vegetables-Rice cropping pattern at FSRD Site: Kaliganj, Satkhira (BRRI)	64
11.2.8	Development of alternate cropping pattern at FSRD Site: Kaliganj, Satkhira (BRRI)	66
11.2.9	Improvement of cropping pattern at FSRD Site: Shyamnagar, Satkhira (BINA)	68
11.2.10	Intercropping system at FSRD Site: Subarnachar, Noakhali (BARI)	69

Sl. No.	Subject	Page No.
11.2.11	Increasing yield through intercropping systems in Sugarcane at FSRD Site: Kaliganj, Satkhira (BRRRI)	71
11.2.12	Participatory variety selection trials on Aus Rice at FSRD site: Subarnachar, Noakhali (BARI)	72
11.2.13	Integrated Plant Nutrition System (IPNS) and Integrated Pest Management (IPM) approaches for watermelon cultivation at FSRD Site: Subarnachar, Noakhali (BARI)	73
11.2.14	On-Farm Verification Trials on different crops variety at FSRD Site: Subarnachar, Noakhali and Jamla, Patuakhali (BARI)	73
11.2.15	Production program of Aus rice at FSRD Site: Noakhali and Patuakhali (BARI)	77
11.2.16	Production program on T. Aman varieties for cropping patterns at FSRD Site: Noakhali and Patuakhali (BARI)	78
11.2.17	Quality seed production of Soybean in <i>Kharif II</i> season at FSRD Site: Subarnachar, Noakhali (BARI)	80
11.2.18	Production program of BRRRI released T. Aman and Boro rice varieties in coastal ecosystem at FSRD Site: Kaliganj, Satkhira (BRRRI)	80
11.2.19	Production program on BINA released different crops variety at FSRD Site: Shyamnagar, Satkhira (BINA)	81
11.3	Livestock Component	83
11.3.1	Vaccination of livestock of co-operative farmers at FSRD Site: Subarnachar, Noakhali (BARI)	83
11.3.2	Vaccination program on cattle at FSRD Site: Jamla, Patuakhali (BARI)	84
11.3.3	Vaccination program on goat at FSRD Site: Kaliganj, Satkhira (BRRRI)	84
11.3.4	Vaccination program on livestock at FSRD site: Shyamnagar, Satkhira (BINA)	85
11.3.5	Improvement of cattle health by de-worming and vaccination at FSRD Site: Jamla, Patuakhali (BARI)	85
11.3.6	Calf rearing at FSRD Site: Jamla, Patuakhali (BARI)	86

Sl. No.	Subject	Page No.
11.3.7	Beef fattening as a source of income generation at FSRD site : Shyamnagar, Satkhira (BINA)	86
11.3.8	Milking cow rearing in farmers household at FSRD Site: Jamla Patuakhali	87
11.3.9	Goat rearing in farmers household at FSRD Site: Kaliganj, Satkhira (BRRRI)	87
11.3.10	Vaccination of poultry birds against major diseases to reduce mortality (%) at FSRD Site: Subarnachar, Noakhali (BARI)	88
11.3.11	Vaccination program on poultry birds at FSRD Site: Jamla, Patuakhali (BARI)	89
11.3.12	Vaccination program on poultry birds at FSRD Site: Kaliganj, Satkhira (BRRRI)	90
11.3.13	Vaccination program on poultry birds at FSRD site: Shyamnagar, Satkhira (BINA)	91
11.3.14	Poultry rearing at farmers household at FSRD Site: Jamla, Patuakhali (BARI)	91
11.3.15	Performance of Sonali Chicken (layer) under semi scavenging system at FSRD Site: Kaliganj, Satkhira (BRRRI)	93
11.3.16	Rearing of Sonali chicken in farmers' house at FSRD Site: Shyamnagar, Satkhira (BINA)	94
11.3.17	Performance of Khaki Campbell duck at farm household at FSRD Site: Kaliganj, Satkhira (BRRRI)	95
11.3.18	Turkey rearing in household condition by cooperative farmers at FSRD Site: Kaliganj, Satkhira (BRRRI)	96
11.3.19	Turkey rearing under scavenging system in farmer's house at FSRD Site: Shyamnagar, Satkhira (BINA)	97
11.3.20	In house pigeon rearing in farmer's household at FSRD Site: Subarnachar, Noakhali	98
11.3.21	Small scale pigeon rearing in farmer's household at FSRD Site Jamla, Patuakhali	99
11.3.22	Small scale pigeon rearing in farmer's household at FSRD Site: Shyamnagar, Satkhira	99

Sl. No.	Subject	Page No.
11.3.23	Napier grass as a fodder crop cultivation at FSRD Site: Subarnachar Noakhali	100
11.3.24	Small-scale Vermicompost production in homestead at FSRD Site: Subarnachar, Noakhali (BARI)	101
11.4	Fisheries Component	101
11.4.1	Maximization of farmer's income through carp polyculture technique at low cost management in perennial pond at FSRD Site: Patuakhali and Noakhali (BARI)	101
11.4.2	Maximization of farmer's income through monoculture technique of different fish species at FSRD Site: Noakhali and Patuakhali (BARI)	103
11.4.3	Fish polyculture in saline Gher system at FSRD Site: Kaliganj, Satkhira (BRRI)	105
11.4.4	Fish polyculture in mini pond system at FSRD Site: Kaliganj, Satkhira (BRRI)	106
11.4.5	Maximization of farmer's income through carp polyculture technique at low cost management in perennial pond at FSRD Site: Shyamnagar, Satkhira (BINA)	108
11.5	Off-Farm Activities	109
11.5.1	Off farm activities at FSRD Site: Subarnachar, Noakhali (BARI)	109
11.5.2	Empowerment of rural women through off -farm activities at FSRD Site: Shyamnagar, Satkhira (BINA)	110
11.6	Income enhancement	111
11.6.1	FSRD site: Jamla , Patuakhali	111
11.6.2	FSRD site Subornachar, Noakhali	111
11.6.3	FSRD Site: Kaliganj, Satkhira (BRRI)	112
11.6.4	FSRD Site: Shyamnagar, Satkhira (BINA)	112
12.	Research highlights	113
12.1	BARI Component	113
12.1.1	Year round vegetable production at FSRD sites, Subarnachar, Noakhali and Dumki, Patuakhali.	113

Sl. No.	Subject	Page No.
12.1.2	Summer Tomato Production in the highlands adjacent to homestead at FSRD site, Subarnachar, Noakhali	115
12.1.3	Movable seedbed for winter vegetables seedlings production at FSRD site Subarnachar, Noakhali	116
12.1.4	Vegetable cultivation under the shade of summer tomato and other adjacent areas of homestead at FSRD site, Subarnachar, Noakhali	117
12.1.5	Vegetable production nearby homestead at FSRD site, Patuakhali	117
12.1.6	On-Farm Verification Trials on different <i>Rabi</i> crops in the farmers field at FSRD sites Noakhali and Patuakhali	118
12.1.7	Agronomic practices of different intercropping system at selected farmers field of FSRD site, Subarnachar in Noakhali	120
12.1.8	Integrated Plant Nutrition System (IPNS) and Integrated Pest Management (IPM) approaches for watermelon cultivation at FSRD site, Subarnachar in Noakhali	122
12.1.9	Quality seed production of Soybean in <i>Kharif II</i> season at FSRD site Subarnachar, Noakhali	123
12.1.10	Participatory variety selection trials on Aus Rice at FSRD site, Subarnachar, Noakhali	124
12.1.11	Production Program of Aus Rice at FSRD site Jamla, Dumki, Patuakhali	125
12.1.12	Land based T. Aman varieties production for cropping patterns at FSRD sites Noakhali and Patuakhali	126
12.1.13	Improvement of the existing Groundnut (Dhaka-1)-Fallow-T. Aman (Sharwna) cropping pattern through inclusion of T. Aus & short duration T. Aman variety at FSRD site, Noakhali	127
12.1.14	Improvement of the existing Soybean (Shohag)-Fallow-T. Aman (BRRI dhan52) cropping pattern through inclusion of modern soybean varieties and Aus rice at FSRD site, Noakhali	128
12.1.15	Improvement of the existing Fallow - Fallow - T. Aman (BR23) cropping pattern through inclusion of underutilized cereal crop and green manuring crop at FSRD site Subarnachar, Noakhali	129

Sl. No.	Subject	Page No.
12.1.16	Development of Potato-Mungbean-T. Aman cropping pattern against Mungbean-Fallow-T. Aman cropping pattern at FSRD site, Jamla, Patuakhali	130
12.1.17	Development of Sunflower - T. Aus -T. Aman cropping pattern against Grasspea - Fallow - T. Aman cropping pattern at FSRD site, Jamla, Patuakhali	131
12.1.18	Vaccination of livestock and poultry birds of co-operative farmers at FSRD Site: Noakhali and Patuakhali	132
12.1.19	Improvement of cattle health by de-worming and vaccination at FSRD Site: Jamla, Patuakhali	132
12.1.20	Calf rearing at FSRD Site: Jamla, Patuakhali	132
12.1.21	Milking cow rearing in farmers household at FSRD Site: Jamla Patuakhali	133
12.1.22	Sonali chicken rearing in the farmers' household at FSRD Site: Jamla, Patuakhali	133
12.1.23	Small scale pigeon rearing in farmer's household at FSRD Site: Patuakhali and Noakhali	133
12.1.24	Maximization of farmer's income through carp polyculture technique through low cost management in the perennial ponds at FSRD Site: Patuakhali and Noakhali	134
12.1.25	Maximization of farmer's income through Monoculture technique at FSRD Site: Noakhali and Patuakhali	135
12.2	BRRRI Component	135
12.2.1	Year-round vegetables production in homestead area at FSRD site, Kaliganj, Satkhira	135
12.2.2	Year-round vegetables production nearby homestead area at FSRD site, Kaliganj, Satkhira	136
12.2.3	Spice's production in the unused shady places of homesteads at the FSRD site Kaliganj, Satkhira	137
12.2.4	Establishment of mini mixed fruit orchard (Mango, Litchi and Ber) in the homestead at FSRD Site Kaliganj, Satkhira	138
12.2.5	Fruit sapling plantation in the homestead area at FSRD site, Kaliganj, Satkhira	139
12.2.6	Improvement of existing Boro-Fallow-T. Aman cropping pattern at FSRD site, Kaliganj, Satkhira	139

Sl. No.	Subject	Page No.
12.2.7	Improvement of existing Vegetables-Rice cropping pattern at FSRD site, Kaliganj, Satkhira	141
12.2.8	Development of alternate cropping pattern at FSRD site, Kaliganj, Satkhira	143
12.2.9	Increasing yield through intercropping different crops with Sugarcane at FSRD Site, Kaliganj, Satkhira.	145
12.2.10	Production program of BRRI released T. Aman and Boro rice varieties in coastal ecosystem at FSRD site, Kaliganj, Satkhira	145
12.2.11	Improvement of productivity in <i>Gher</i> system at FSRD site, Kaliganj, Satkhira	147
12.2.12	Intensify the productivity of <i>Gher</i> system through fish-duck-vegetables cultivation at FSRD site, Kaliganj, Satkhira	148
12.2.13	Performance of Sonali Chicken (Layer) at farm household level at FSRD site, Kaliganj, Satkhira	149
12.2.14	Performance of Khaki Campbell duck rearing in the farmers' household at FSRD site, Kaliganj, Satkhira	149
12.2.15	Turkey rearing in household condition by cooperative farmers at FSRD Site: Kaliganj, Satkhira (BRRI)	150
12.2.16	Goat rearing in the farmers household at FSRD site, Kaliganj, Satkhira	151
12.2.17	Fish poly-culture in saline <i>Gher</i> system at FSRD site, Kaliganj, Satkhira	151
12.2.18	Fish poly-culture in mini pond at FSRD site, Kaliganj, Satkhira	153
12.3	BINA Component	154
12.3.1	Year-round vegetables production in homestead area at the FSRD Site Shyamnagar, Satkhira	154
12.3.2	High value vegetable production nearby homestead at FSRD site Shyamnagar, Satkhira	155
12.3.3	Improvement of the existing Boro-Fallow-T. Aman cropping pattern by improved Boro-Mustard-T.Aman cropping pattern at the FSRD Site Shyamnagar, Satkhira	155

Sl. No.	Subject	Page No.
12.3.4	Production program on BINA released rice variety at the FSRD Site Shyamnagar, Satkhira	156
12.3.5	Vaccination program for cattle, goats and chickens at FSRD Site Shyamnagar, Satkhira	157
12.3.6	Turkey rearing under scavenging system at farmer's homestead at FSRD Site Shyamnagar, Satkhira	157
12.3.7	Sonali chicken rearing at Farmers' household at FSRD Site Shyamnagar, Satkhira	158
12.3.8	Small scale pigeon rearing in the farmer's household at FSRD Site Shyamnagar, Satkhira	158
12.3.9	Carp polyculture in farmer's seasonal pond at FSRD Site Shyamnagar, Satkhira	159
B.	Implementation Status	160
1.	Procurement	160
2.	Establishment/renovation facilities	161
3.	Training/study tour/seminar/workshop/conference organized	161
C.	Financial and Physical Progress	162
D.	Achievement of Sub-project by objectives (Tangible form): Technology generated/developed	164
E.	Information/Knowledge generated/Policy generated	165
F.	Materials Development/Publication made under the Sub-project	177
G.	Description of generated Technology/Knowledge/Policy	179
i	Technology Fact Sheet	179
ii	Effectiveness in Policy Support	197
H.	Technology/Knowledge generation/Policy support	197
i	Immediate impact on generated technology	197
ii	Generation of new knowledge that help in developing more technology in future	197
iii	Technology transferred that help increased agricultural productivity and farmers' income	198
iv	Policy Support	199

Sl. No.	Subject	Page No.
I.	Information regarding Desk and Field Monitoring	199
i	Desk Monitoring	199
ii	Field Monitoring	199
iii	Weather data, flood/salinity/drought level (if applicable) and natural calamities	201
J.	Sub-project Auditing	202
K.	Lessons Learned	203
L.	Challenges	203
M.	Suggestions for Future Planning	203
N.	References	205

List of Tables

Sl. No.	Title	Page No.
10.1	Sub-project locations/sites	5
10.2	Category-wise selected farmers information of different FSRD sites	5
10.3	Modified Atkapalia model (BARI, Noakhali)	6
10.4	Modified Lebukhali Model (BARI, Patuakhali)	8
10.5	Modified Laudove model followed at FSRD Site: Kaliganj, Shatkhira (BARI)	8
10.6	Modified Laudove model followed at FSRD Site: Shyamnagar, Shatkhira (BINA)	9
10.7	Agronomic practices of Summer Tomato Production at FSRD site, Subarnachar, Noakhali during <i>Kharif</i> season 2019 and 2020	10
10.8	Winter vegetables production at FSRD site, Subarnachar, Noakhali during <i>Rabi</i> season, 2019-2020 and 2020-2021	11
10.9	Cropping scheme for Sorjan system at FSRD Site, Jamla, Patuakhali	11
10.10	Agronomic practices for different Rabi and Kharif vegetables production in Sorjan bed during 2018 and 2021	12
10.11	Production practices followed in nearby homestead area at FSRD site, Kaliganj, Satkhira during 2018-21	13
10.12	Management Practices of Ginger & Turmeric at FSRD site, Kaliganj, Satkhira during 2018-21	13
10.13	Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali (BARI)	14
10.14	Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali (BARI)	15
10.15	Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali (BARI)	15
10.16	Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali (BARI)	16
10.17	Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali (BARI)	16
10.18	Crop management practices of improved and existing cropping pattern during 2018-20 at FSRD site, Kaliganj, Satkhira (BARI)	17
10.19	Crop management practices of improved and existing cropping pattern during 2018-20 at FSRD site, Kaliganj, Satkhira (BARI)	17

Sl. No.	Title	Page No.
10.20	Crop management practices of improved and existing cropping pattern during 2018-19 at FSRD site, Kaliganj, Satkhira (BRI)	18
10.21	Crop management practices of improved and existing cropping pattern during 2018-19 at FSRD site, Kaliganj, Satkhira (BRI)	18
10.22	Crop management practices of improved and existing cropping pattern during 2019-20 at FSRD site, Kaliganj, Satkhira (BRI)	19
10.23	Crop management practices of alternate cropping pattern and existing cropping pattern during 2018-20 at FSRD site, Kaliganj, Satkhira (BRI)	19
10.24	Crop managements of improved and existing cropping pattern at FSRD Site : Shyamnagar, Satkhira during 2019-20 (BINA)	20
26.25	Agronomic practices followed in different On-Farm Verification Trials at FSRD site, Noakhali in coastal ecosystem	21
10.26	Agronomic practices followed in different On-Farm Verification Trials at FSRD site, Patuakhali.	22
10.27	Seed rate and fertilizer doses practiced in On-Farm Verification Trials on different Rabi crops at FSRD sites Noakhali and Patuakhali (2018 to 2020)	24
10.28	Agronomic practices of different intercropping system trials at selected farmers field of FSRD site, Subarnachar in Noakhali (2018-2020)	24
10.29	Crop managements of intercropping system trials at FSRD site: Kaliganj, Satkhira during 2019-20	25
10.30	Management practices followed by the cooperative farmers in watermelon production at FSRD site, Subarnachar, Noakhali during December, 2018 to January, 2021	26
10.31	Crop management practices in the Researcher-led Participatory Variety Selection (RPVS) at FSRD Site Noakhali during Kharif season of 2019 and 2020	26
10.32	Crop management practices in the Production program of Aus rice during <i>Kharif</i> season at FSRD site Jamla, Patuakhali	27
10.33	Varieties, farmers categories, plot size, date of transplanting and date of harvesting under production program of T. Aman during Kharif II season of 2018 - 2020 at FSRD site, Subarnachar, Noakhali (BARI)	27
10.34	Varieties, farmers categories, area, date of transplanting and date of harvesting of T. Aman rice during Kharif II season of 2018 - 2020 at FSRD site, Patuakhali (BARI)	28
10.35	Agronomic practices followed in quality seed production of soybean during late Kharif II season for upcoming Rabi season at FSRD site, Noakhali	28

Sl. No.	Title	Page No.
10.36	Farmers number, area, date of sowing and date of harvesting of T. Aman rice under production program during 2018-2020 at FSRD site, Kaliganj, Satkhira	29
10.37	Farmers number, area, date of sowing and date of harvesting of Boro rice under production program during 2018-2020 at FSRD site, Kaliganj, Satkhira	29
11.1	Year-round vegetables and fruits production from different niches in different categories of farm households at FSRD Site, Subarnachar, Noakhali during February 2018 – January 2021	34
11.2	Year-round homestead production system and income from different niches at FSRD Site, Subarnachar, Noakhali during 2018 to 2021 (Avg. of 04 farmers from each category)	36
11.3	Year-round vegetables & fruits production system and utilization pattern before and after intervention among different categories of farmers at FSRD Site, Subarnachar, Noakhali during February 2018 to January 2021	38
11.4	Year-round vegetables and fruits production from different niches in different categories of farm households at FSRD Site, Jamla, Patuakhali during February 2018 - January 2021 (Avg. of 04 farmers from each group)	39
11.5	Year-round homestead production system and income from different niches at FSRD Site, Dumki, Patuakhali during February 2018 to January 2021 (Avg. of 04 farmers from each group)	41
11.6	Year-round vegetables & fruits production system and utilization pattern before and after intervention among different categories of farmers at FSRD site, Patuakhali under coastal ecosystem during February 2018 to January 2021 (Avg. of 04 farmers from each category)	42
11.7	Year-round vegetables production of nine farm households using different niches at FSRD site Kaliganj, Satkhira during 2018-21.	43
11.8	Year-round vegetables production and income of nine farm households at FSRD site Kaliganj, Satkhira during 2018-21	43
11.9	Year-round vegetables production and disposal pattern before and after intervention during 2018-21 at FSRD Site, Kaliganj, Satkhira	44
11.10	Round the year vegetables and fruits production from different niches in farmer's household during February 2018 to January 2021 at FSRD site Shyamnagar, Satkhira	45
11.11	Round the year vegetables and fruits production from different niches of homestead at FSRD site Shyamnagar, Satkhira during Feb. 2018 to Jan. 2021 (average of 12 farmers)	46

Sl. No.	Title	Page No.
11.12	Round the year vegetables and fruits production and utilization pattern before and after intervention during Feb 2018 - Jan. 2021 at FSRD site Shyamnagar, Satkhira (Average of 12 farmers)	47
11.13	Average Yield of Summer tomato varieties at FSRD Site, Subarnachar, Noakhali, during Kharif season of 2019 and 2020	47
11.14	Winter vegetables production under the shade of summer tomato and other places near homestead at FSRD site, Subarnachar, Noakhali during 2019 and 2020	48
11.15	Year-round vegetables production (kg) nearby homesteads of three different farmers at FSRD site Kaliganj, Satkhira during 2018-2021	49
11.16	Year-round vegetables production and income from nearby homesteads of three different farmers at FSRD site Kaliganj, Satkhira during 2018-21 (Comparative data)	49
11.17	Year-round vegetables production and disposal pattern in nearby homestead before and after intervention at FSRD site Kaliganj, Satkhira during 2018-21	50
11.18	Yield and economics of high value vegetables production nearby homestead before and after intervention at FSRD site Shyamnagar, Satkhira during Feb 2018 - Jan 2021	51
11.19	Vegetables production in Sorjan bed during Rabi (2019-20) and Kharif (2020) season in farmers field at FSRD Site, Jamla, Patuakhali	52
11.20	Vegetables production in raised bed at selected farmers field of FSRD site, Jamla Patuakhali during Rabi (2019-20) and Kharif (2020) season	52
11.21	Yield, cost and return of ginger and turmeric production at FSRD, Kaliganj, Satkhira during 2018-20	54
11.22	Number of farmers, number of vine and creeper types for growing Chui jhal spices at FSRD site, Kaliganj, Satkhira during 2018-20	54
11.23	Distribution of different fruit tree saplings among the cooperator farmers at FSRD Site, Shyamnagar, Satkhira during 2018 to 2021	55
11.24	Cost and return analysis of movable seedbed at FSRD Site, Subarnachar, Noakhali during late Kharif II season of 2019 and 2020	56
11.25	Family labor utilization pattern for homestead production system at four FSRD Sites of coastal ecosystem	57

Sl. No.	Title	Page No.
11.26	Average yield and economic analysis of improved and existing cropping pattern at the FSRD Site, Subarnachar, Noakhali during 2018-19 and 2019-2020	58
11.27	Average yield and economic analysis of improved and existing cropping pattern at the FSRD Site, Subarnachar, Noakhali during 2018-19 and 2019-2020	59
11.28	Performance of improved and existing cropping pattern at FSRD Site, Subarnachar, Noakhali	61
11.29	Performance of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali during 2018-19 and 2019-2020	62
11.30	Performance of improved and existing cropping pattern at FSRD Site, Jamla, Dumki, Patuakhali during 2018-19 and 2019-2020	62
11.31	Yield and economic analysis of alternate and existing cropping pattern at the FSRD site, Kaliganj, Satkhira during 2018-2019	63
11.32	Yield and cost return analysis of alternate cropping pattern at the FSRD Site, Kaliganj, Satkhira during 2019-20	64
11.33	Yield and Economic analysis of alternate and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2018-19	65
11.34	Yield and Economic analysis of alternate cropping pattern at FSRD site, Kaliganj, Satkhira during 2019-20	65
11.35	Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2018-19	66
11.36	Yield and economic analysis of alternate cropping pattern at FSRD site, Kaliganj, Satkhira during 2019-20	68
11.37	Yield and economic analysis of alternate and existing cropping pattern at FSRD site Shyamnagar, Satkhira during 2018-2020	68
11.38	Yield, rice equivalent yield (REY), LER and economic analysis of Garlic-Cowpea intercropping system at FSRD Site, Noakhali during Rabi season of 2018-19	70
11.39	Yield, rice equivalent yield (REY), LER and economic analysis of Sweet Potato-Cowpea intercropping system at FSRD Site, Noakhali during Rabi season of 2018-19	70
11.40	REY and economic analysis of Sweet potato - Cowpea and Garlic + Cowpea intercropped system at FSRD Site, Subarnachar, Noakhali during Rabi season of 2018-19	71
11.41	Yield and economic analysis of different intercropping system at FSRD site, Kaliganj, Satkhira during 2019-2020	71

Sl. No.	Title	Page No.
11.42	Average yield of different Aus rice varieties at selected farmers of FSRD Site, Subarnachar, Noakhali during Kharif season of 2019 and 2020	72
11.43	Comparison of yield and economic performance of watermelon production under different cultivation practices at FSRD Site, Subarnachar, Noakhali during 2019 and 2020	73
11.44	Average yield and economic analysis of different Rabi crops in On-farm verification trials conducted at FSRD site, Subarnachar, Noakhali	75
11.45	Average yield and Economic return of different on-farm verification trials at FSRD Site, Jamla, Patuakhali during <i>Rabi</i> season of 2019-20	76
11.46	Performance of Power Tiller Operated Seeder in different crops production at different FSRD sites under coastal ecosystem	77
11.47	Yield, cost and return of Aus Rice variety at FSRD Sites, Noakhali and Patuakhali during Kharif season of 2019 and 2020	78
11.48	Yield of different T. Aman rice varieties at FSRD Site, Subarnachar, Noakhali during Kharif II season of 2019 and 2020	79
11.49	Average yield of different T. Aman rice varieties at FSRD site, Jamla, Patuakhali during Kharif II season of 2019 and 2020	79
11.50	Yield and economic return in quality seed production of Soybean during late Kharif II season for upcoming Rabi season at FSRD Site, Subarnachar, Noakhali	80
11.51	Yield, cost and return analysis of T. Aman rice varieties at FSRD site, Kaliganj, Satkhira during T. Aman season, 2018-2020	80
11.52	Yield, cost and return analysis of Boro rice varieties at FSRD site, Kaliganj, Satkhira during Boro season, 2018-20	81
11.53	Yield, cost and return analysis under production program of Binadhan-11 at FSRD Site, Shyamnagar, Satkhira	82
11.54	Yield and cost return analysis of mustard varieties under production program at FSRD Site, Shyamnagar, Satkhira during 2020-2021	82
11.55	Yield and cost return analysis of grasspea varieties under production program at FSRD Site, Shyamnagar, Satkhira	82
11.56	Mortality (%) of livestock before and after vaccination against major diseases at FSRD site Subarnachar, Noakhali during 2018 - 2021.	83
11.57	Effect of cattle vaccination at FSRD site, Jamla, Dumki, Patuakhali	84
11.58	Mortality (%) of goats before and after vaccination against PPR disease at FSRD site Kaliganj, Satkhira	84

Sl. No.	Title	Page No.
11.59	Mortality (%) of livestock before and after vaccination against major diseases at FSRD Site Shyamnagar, Satkhira during Feb. 2018- Jan. 2021	85
11.60	Livestock covered by de-worming and vaccination program at FSRD site Jamla, Dumki, Patuakhali	85
11.61	Effect of deworming and vaccination on body weight, average lactation yield and lactation period of cattle at FSRD Site, Jamla, Patuakhali	85
11.62	Income from calf rearing at FSRD Site: Jamla, Patuakhali during 2019-20	86
11.63	Body weight and market value after 180 days fattening of cattle at FSRD Site, Shyamnagar, Satkhira during June 2020-January 2021	86
11.64	Milk production and income from milking cow rearing at FSRD Site, Jamla, Patuakhali during April 2020 – January 2021	87
11.65	Production of goat kid from she goat rearing at FSRD Site, Kaliganj, Satkhira during 2018 –2021	87
11.66	Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD Site, Subarnachar, Noakhali during 2018-2021	89
11.67	Number of birds vaccinated and mortality rate before and after vaccination at FSRD site, Jamla, Dumki, Patuakhali during 2018-2021	90
11.68	Vaccination program of distributed poultry birds at FSRD site, Kaliganj, Satkhira during Feb 18-Dec 20	90
11.69	Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD Site Shyamnagar, Satkhira during 2018- 2021	91
11.70	Average performances of Sonali chicken for meet purpose at farmers' level after 6 months of rearing at FSRD site Jamla, Dumki, Patuakhali during 2018- 2021	92
11.71	Average production performance and egg disposal pattern per farmer of Sonali chicken (layer) rearing at FSRD site, Kaliganj, Satkhira during 2018-21	93
11.72	Average performances of Sonali chicken for meet purpose at farmers' homestead after 6 months of rearing at FSRD site Shyamnagar, Satkhira during February 2018- January 2021	94
11.73	Production performance of Khaki Campbell duck and egg disposal pattern at FSRD site, Kaliganj, Satkhira during Feb. 2018 - Jan. 2021	95
11.74	Average performances of Turkey rearing after 12 months at farmers' level during 2018-21 at FSRD Site, Kaliganj, Satkhira	96
11.75	Average performances of Turkey in farmers' house after six months of rearing at FSRD Site Shyamnagar, Satkhira during 2018- 2021	97

Sl. No.	Title	Page No.
11.76	Performance of in-house pigeons rearing in farmers' household at FSRD site Subarnachar, Noakhali during February 2020- January 2021	98
11.77	Average per farm income from in house pigeon rearing at FSRD Site, Jamla, Patuakhali during February 2020 to January 2021	99
11.78	Performance of supplied pigeons at FSRD site Shyamnagar, Satkhira during December 2019- January 2021	100
11.79	Production of Napier grass at FSRD Site, Subarnachar, Noakhali during 2018-2021	100
11.80	Average Production cycle of Vermicompost at FSRD site, Subarnachar Noakhali	101
11.81	Performance of carp polyculture in pond at the FSRD Sites Patuakhali and Noakhali after 12 months culture	102
11.82	Total fish production, utilization pattern in both FSRD Sites Patuakhali and Noakhali during Feb. 2018- Jan. 2021	102
11.83	Production and economic analysis of fish culture at FSRD sites Patuakhali and Noakhali from Feb. 2018- Jan. 2021	103
11.84	Performance of carp polyculture per pond in both FSRD site Patuakhali and Noakhali during Feb. 2018- Jan. 2021	103
11.85	Fish production, utilization pattern in both FSRD site Patuakhali and Noakhali during Feb. 2018- Jan. 2021.	104
11.86	Average total production and cost return analysis of fish culture per household in both FSRD site Patuakhali and Noakhali from Feb. 2019- Jan. 2021	105
11.87	Average Performance of Gher polyculture fish farming at FSRD site Kaliganj, Satkhira during 2018-21	105
11.88	Fish production, utilization pattern and income before and after intervention at FSRD site Kaliganj, Satkhira during 2018-21	106
11.89	Average yearly performance of fish polyculture at FSRD Site Kaliganj, Satkhira during 2018-21	107
11.90	Fish production, utilization pattern and income before and after intervention at FSRD site Kaliganj, Satkhira during 2018-21	107
11.91	Performance of carp polyculture at FSRD site Shyamnagar, Satkhira during Feb 2018- Jan. 2021	108
11.92	Fish production, utilization pattern and income before and after intervention at FSRD site Shyamnagar, Satkhira during Feb 2018- Jan. 2021	108
11.93	Cost and return of off-farm activities at FSRD site, Subarnachar, Noakhali	109

Sl. No.	Title	Page No.
11.94	Economic analysis of vermicompost production at FSRD Site, Shyamnagar, Satkhira during Feb. 2019-Jan. 2021	110
11.95	Technologies used and return from different sub-systems of integrated farming systems at FSRD site Jamla, Patuakhali during the years of February 2018 to January 2021	111
11.96	Technologies used and return from different sub-systems of integrated farming systems at FSRD Site, Noakhali during the years of February 2018 to January 2021	111
11.97	Technologies used and return from different sub-systems of integrated farming systems at FSRD Site, Kaliganj, Satkhira during the years of February 2018 to January 2021	112
11.98	Technologies used and return from different sub-systems of integrated farming systems at FSRD Site, Shyamnagar, Satkhira during the years of February 2018 to January 2021	113
12.1	Modified Lebukhali Model	114
12.2	Modified Atkapalia Model	115
12.3	Agronomic practices for different Rabi and Kharif vegetables production in Sorjan bed during 2019 and 2020	118
12.4	Seed rate and fertilizer doses practiced in On-Farm Verification Trials on different Rabi crops at FSRD sites Noakhali and Patuakhali (2018 to 2020)	119
12.5	Agronomic practices of different intercropping system trials at selected farmers field of FSRD site, Subarnachar in Noakhali during 2018-2020	121
12.6	Management practices followed by the cooperative farmers in watermelon production at FSRD site, Subarnachar, Noakhali during December, 2018 to January, 2021	123
12.7	Agronomic practices followed in quality seed production of soybean during late Kharif II season for upcoming Rabi season at FSRD site, Subarnachar, Noakhali	123
12.8	Crop management practices in the Researcher-led Participatory Variety Selection (RPVS) Trials at on-farm condition during <i>Kharif</i> season of 2019 and 2020	124
12.9	Crop management practices in the Production program of Aus rice during <i>Kharif</i> season of 2019 and 2020	126
12.10	Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali	127
12.11	Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali	128

Sl. No.	Title	Page No.
12.12	Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali	130
12.13	Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali	131
12.14	Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali	131
12.15	Vegetables production in homestead area followed Laudove model at FSRD Site, Kaliganj, Satkhira during 2018-21	136
12.16	Niches and cropping patterns followed for vegetables production in nearby homestead area at FSRD Site, Kaliganj, Satkhira during February 2018- January 2021	137
12.17	Management Practices of Ginger & Turmeric at Kaliganj, Satkhira, during February 2018- January 2021	138
12.18	Crop management practices of improved and existing cropping pattern during 2018-20 at FSRD site, Kaliganj, Satkhira	140
12.19	Crop management practices of improved and existing cropping pattern at FSRD site, Kaliganj, Satkhira, 2019-20	140
12.20	Cropping patterns followed at FSRD site, Kaliganj, Satkhira (2018-20)	141
12.21	Crop management practices of improved and existing cropping pattern during 2018-19 at FSRD site, Kaliganj, Satkhira	141
12.22	Crop management practices of improved and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2018-19	142
12.23	Crop management practices of improved and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2019-20	142
12.24	Cropping patterns followed at FSRD Site, Kaliganj, Satkhira during 2018-20	143
12.25	Crop management practices of improved cropping pattern at FSRD site, Kaliganj, Satkhira, 2018-20	144
12.26	Crop management practices of improved cropping pattern at FSRD site, Kaliganj, Satkhira, 2018-20	144
12.27	Managements of crop used in winter crop and sole crop (Sugarcane) at FSRD site, Kaliganj, Satkhira during 2019-20	145
12.28	Crop management practices for T. Aman rice at FSRD site, Kaliganj, Satkhira, in 2018	146
12.29	Crop management practices for Boro rice at FSRD site, Kaliganj, Satkhira, 2018-2020	146
12.30	Stocking density of fish in Gher at FSRD site, Kaliganj, Satkhira	147

Sl. No.	Title	Page No.
12.31	Stocking density of fishes in Gher at FSRD site, Kaliganj, Satkhira	148
12.32	Stocking density of fish in Gher at FSRD site, Kaliganj, Satkhira	152
12.33	Stocking density of fish in mini pond at FSRD site, Kaliganj, Satkhira	153
12.34	Loudove model for year-round vegetables and fruit production in homestead area at the FSRD Site Shyamnagar, Satkhira	154
12.35	Agronomic performance of improved and existing cropping pattern at FSRD Site, Shyamnagar, Satkhira.	156
12.36	Production of Aman rice at FSRD site, Shyamnagar, Satkhira, 2019-20	157
B.1.1	Procurement of equipment and capital items of BARC component	160
B.1.2	Procurement of equipment and capital items of BARI component	160
B.1.3	Procurement of equipment and capital items of BIRRI component	160
B.1.4	Procurement of equipment and capital items of BINA component	161
B.3.1	Information on training/workshop/meeting organized by BARC	161
B.3.2	Information on training/workshop/field days arranged by BARI	161
B.3.3	Information on training/workshop/field days arranged by BIRRI	162
B.3.4	Information on training/workshop/method demonstration/field day/meeting organized by BINA	162
C.1	Combined financial and physical progress	162
C.2	Financial and physical progress of BARC Component	162
C.3	Financial and physical progress of BARI Component	163
C.4	Financial and physical progress of BIRRI Component	163
C.5	Financial and physical progress of BINA Component	164
D.1.	Technology generated/developed by BARI Component	164
D.2.	Technology generated/developed by BIRRI Component	165
D.3.	Technology generated/developed by BINA Component	165
E.1	Information/Knowledge generated/Policy generated by BARI Component	165
E.2	Information/Knowledge generated/Policy generated byBIRRI Component	171
E.3	Information/Knowledge generated/Policy generated by BINA Component	175
F.1	Materials Development/Publication made under the Sub-project by BARC Component	177
F.2	Materials Development/Publication made under the Sub-project by BARI Component	177

Sl. No.	Title	Page No.
F.3	Materials Development/Publication made under the Sub-project by BRRRI Component	177
F.4	Materials Development/Publication made under the Sub-project by BINA Component	177
G.1	Modified Lebukhali Model or Jamla Model	179
G.2	Description of movable seedbed established at medium high land adjacent to homestead areas in FSRD site, Subarnachar, Noakhali during late Kharif II to early Rabi season.	189
G.3	Economic return from Movable seedbed established at selected farmer field of FSRD site, Subarnachar Upazila, Noakhali during late Kharif II season of 2019 and 2020	190
G.4	Brief description of integrated rice-fish-vegetables cultivation technology	191
I.1	Field Monitoring information of BARI Component	199
I.2	Field Monitoring information of BRRRI Component	200
I.3	Field Monitoring information of BINA Component	200
J.1	Sub-project auditing information of BARC component	202
J.2	Sub-project auditing information of BARI component	202
J.3	Sub-project auditing information of BRRRI component	202
J.4	Sub-project auditing information of BINA component	202

List of Figure

Sl. No.	Title	Page No.
9.1	Map FSRD Site Subarnachar, Noakhali	3
9.2	Map FSRD site Dumki, Patuakhali	3
9.3	Map FSRD site Kaliganj, Satkhira	4
9.4	Map FSRD site Shyamnagar, Satkhira	4
10.1	Bed diagram of Modified Sorjan method	12
11.1	Average cash income, total income and gross margin for three years per farm family at FSRD Site, Kaliganj, Satkhira during 2018-21	45
11.2	Average economic returns from three farmers nearby homestead vegetables production at FSRD Site, Kaliganj, Satkhira during 2018-21	51
12.1	Bed diagram of Modified Sorjan method	118
G. 1	Bed diagram of Sorjan for nearby fallow land	180
I.1	Total rainfall, Maximum and Minimum temperature of Noakhali during the project intervention period (May, 2017 to September, 2018)	201

List of Picture

Sl. No.	Title	Page No.
10.1	Atkapalia model (i to iii) and modified Atkapalia model (iv to vi) followed year-round vegetables production at FSRD site, Noakhali (2018- 2020)	7
10.2	Homestead vegetables production at FSRD site Shyamnagar, Shatkhira	10
10.3	Land modification for producing vegetables throughout the year adjacent to homestead or in homestead	12
10.4	Moveable seedbed preparation and seedling production	31
11.1	Year-round vegetables production in different categories farmers homestead at FSRD Site, Subarnachar, Noakhali	39
11.2	Year-round vegetables production in different categories farmers homestead at FSRD site, Jamla, Dumki, Patuakhali	42
11.3	Year-round vegetables production in homestead area at FSRD Site: Kaliganj, Satkhira	44
11.4	Production of different summer tomato varieties at FSRD site, Subarnachar, Noakhali during Kharif season of 2019 and 2020	48
11.5	Vegetables production under the shade of previously grown summer tomato at FSRD Site, Subarnachar, Noakhali	48
11.6	Vegetables production nearby homestead at FSRD Site, Kaliganj, Satkhira	49
11.7	Vegetables production in Sorjan and Raised bed at FSRD Site, Jamla, Patuakhali	53
11.8	Spices production in the shady places at FSRD Site, Kaliganj, Satkhira	55
11.9	Fruit Sapling distribution at FSRD Site Shyamnagar, Satkhira	56
11.10	Seedling production and selling from moveable seedbed at FSRD Site, Subarnachar Noakhali	57
11.11	Family labour utilization patterns at FSRD Sites under coastal ecosystem	57
11.12	Improved cropping pattern practiced at FSRD Site, Subarnachar, Noakhali	58
11.13	Improved cropping pattern practiced at FSRD Site, Subarnachar, Noakhali.	60

Sl. No.	Title	Page No.
11.14	Improved cropping pattern practiced at FSRD site, Subarnachar, Noakhali.	61
11.15	Improved cropping pattern practiced at FSRD Site, Jamla, Patuakhali	62
11.16	Improved cropping pattern practiced at FSRD Site, Kaliganj, Satkhira	64
11.17	Improved cropping pattern practiced at FSRD Site, Kaliganj, Satkhira	66
11.18	Developed cropping pattern practiced at FSRD Site, Kaliganj, Satkhira	66
11.19	Intercropping systems in sugarcane at FSRD Site, Kaliganj, Satkhira	71
11.20	Different Aus rice varieties in Researcher led Participatory Variety Selection trials at FSRD Site, Noakhali during Kharif season (2019 and 2020)	72
11.21	Watermelon production at FSRD Site, Subarnachar, Noakhali	73
11.22	Different on-farm verification trials at FSRD sites Noakhali and Patuakhali	77
11.23	Aus rice production at FSRD Site, Subarnachar, Noakhali during Kharif season (2019 and 2020)	78
11.24	Different T. Aman rice varieties production at FSRD Site, Subarnachar, Noakhali	79
11.25	Production program of T. Aman and Boro rice at FSRD site, Kaliganj, Satkhira during 2018-20	81
11.26	Vaccination program at FSRD Site, Subarnachar, Noakhali	84
11.27	De-worming and vaccination at FSRD Site: Jamla, Patuakhali	85
11.28	Calf rearing at FSRD Site: Jamla, Patuakhali	86
11.29	Milking cow rearing and fodder production at FSRD site, Jamla, Patuakhali	87
11.30	Goat rearing at FSRD Site , Kaliganj, Satkhira during 2018-20	88
11.31	Poultry vaccination at FSRD Site: Jamla, Patuakhali	89
11.32	Poultry Vaccination program at FSRD Site Kaliganj, Satkhira	91
11.33	Poultry rearing at FSRD Site Jamla, Patuakhali	91
11.34	Sonali Chicken rearing at FSRD Site, Jamla, Patuakhali	92

Sl. No.	Title	Page No.
11.35	Sonali chicken rearing at FSRD Site, Kaliganj, Satkhira during 2018-20	94
11.36	Khaki Campbell duck rearing at FSRD Site Kaliganj, Shatkhira	95
11.37	Turkey rearing at FSRD Site , Kaliganj, Satkhira	97
11.38	Pigeon rearing at FSRD Site, Subarnachar, Noakhali	99
11.39	Pigeon rearing at FSRD Site, Jamla, Patuakhali	99
11.40	Fodder production, feeding and body weight measurement of the cattle at FSRD site, Subarnachar , Noakhali	100
11.41	Vermicompost production and utilization at FSRD site, Subarnachar, Noakhali	101
11.42	Fish culture at FSRD sites Noakhali and Patuakhali	104
11.43	Fish polyculture in Gher at FSRD Site, Kaliganj, Satkhira	106
11.44	Fish polyculture in mini pond at FSRD Site: Kaliganj, Satkhira	108
11.45	<i>Schumannianthus dichotoma</i> plant production and Shital Pati made by co-operative farmers at FSRD site, Subarnachar, Noakhali	110
G.1	Integrated Rice-Fish-Vegetables Cultivation in Gher System	194
I.1	Field visit by monitoring team	200
I.2	Open discussion & workshop	201

Executive Summary

Bangladesh is a densely populated deltaic floodplain land bordered by the Bay of Bengal in the southern region. There are about 2.85 million hectares of the coastal and offshore areas of Bangladesh of which about 0.83 million hectares are arable lands. Agricultural land use in coastal areas is very poor, which is much lower than country's average cropping intensity. Most of the farmers living in the coastal areas are resource poor and burdened by the low production rates of crops. Salinity intrusion due to reduction of fresh water flow from upstream, salinization of groundwater and fluctuation of soil salinity are major concern of these areas. Moreover, frequently occurrence of cyclones and tidal surge are making the coastal area more climate vulnerable. In the southern region of the country, about 10% land is affected by salinity. In the dry season, salinity rises up making (figure) land difficult for cultivation and the salinity goes down during monsoon can possible to crop cultivation. The subsistence farms in coastal areas are highly diversified with complex relationships among the various sub-system and within a subsystem enterprises. While there are different production alternatives, farmers have a limited set of resources. 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. To ensure resource optimization, maximize production from agricultural resources in the coastal zone, farming systems research and development activities were initiated under the Program Based Research Grant (PBRG) sub-project on "Climate Resilient Farming Systems Research and Development for the Coastal Ecosystem". The sub-project has been implemented by Bangladesh Agricultural research institute (BARI), Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) with the coordination of Bangladesh Agricultural Research Council (BARC). The sub-project started from February 2018 and end January 2022. The objectives were to generate climate resilient and site-specific farming system research and development technologies, fine tuning and dissemination of farming system along with its component technologies and to integrate component technologies for maximizing farm productivity. The sub-project activities have been implemented in four Farming System Research and Development sites (FSRD) located at Subarnachar, Noakhali ; Jamla, Patuakhali; Kaliganj, Satkhira and Shyamnagar; Satkhira. According to the aim of the sub-project, resource poor farmers viz. marginal, small and medium having major components of farming and sizable homestead under single ownership were targeted and twelve farm households from two villages of each site covering four farmers from each category were selected. Prior to implement the sub-project activities, a baseline survey of individual households was carried out. On the basis of farmer's existing practices, their needs and choices, several alternatives of technologies of crops, cropping pattern, livestock, fisheries, agroforestry, off-farm activities and other components were incorporated with active participation of the farmers. Integrated approach has been followed for income generation and livelihood improvement of the farmers.

BARI Part: In crop component, effort was given for the improvement of cropping pattern as well as development of alternate cropping pattern and on-farm verification of high yielding crop varieties. For improvement of cropping pattern, T. Aman rice varieties (BRRI dhan23, BRRI dhan52 and BRRI dhan87) were cultivated with the farmers of Subarnachar, Noakhali and Jamla, Patuakhali. In two locations, 5 alternate and improved cropping patterns trial were conducted which were Groundnut (Dhaka-1)- T. Aus ((Binadhan-19) - T. Aman (BRRI dhan87), Proso millet (BARI Cheena-1) - Green manure - T. Aman (BR23), Soybean (BARI Soybean-5/ 6)- T. Aus (BRRI dhan85)-T. Aman (BRRI dhan52), Potato (BARI Alu-72) - T. Aus (BARI Mung-6) -T. Aman (BRRI dhan49) and Sunflower (BARI Surjomukhi-2)- T. Aus (BRRI dhan48)-T. Aman (BRRI dhan52). The results showed that the farmers obtained higher yield and economic return from alternate cropping pattern with high yielding varieties and improved management practices. Besides on-farm trials, participatory variety selection on Aus rice crop was done with the modern variety such as BR26 (3.53 th⁻¹), BRRI dhan48 (3.75 th⁻¹), BRRI dhan82 (3.66 th⁻¹), BRRI dhan83 (3.64 th⁻¹), BRRI dhan85 (4.02 th⁻¹) and Binadhan-19 (3.87 th⁻¹) in Noakhali site. On the other hand, production program of Aus rice with BRRI dhan48 as well as short duration non rice crops varieties were carried out in both locations in two consecutive years. With the aim of improving soil health, green manuring crops

were cultivated and eventually, incorporated just before flowering. Year-round vegetables production through “modified Atkapalia Model” and “Modified Lebukhali Model” were practiced among the co-operative farmers. Results revealed that, intake of vegetables were markedly increased (Avg.190%) by all families. In addition, most of the farmers distributed about 20-50 kg of their produced vegetables among neighbors and relatives. They also sold some amount of vegetables (50-337 kg) in the local market. Vegetable’s production was increased maximum at Patuakhali (505%) and minimum at Noakhali (60%) compared to before intervention. In vegetables production in and around the homestead high value crop like summer tomato (BARI Hybrid Tomato-8, 10 and11), cabbage, cauliflower and broccoli cultivation were introduced among the farmers. Highest gross margin (Tk. 1119544) was obtained from summer tomato. Sorjan and raised bed method were implemented for vegetables production throughout the year in Patuakhali site. Moreover, moveable seedbed was introduced for production of early winter vegetables seedling in Noakhali. Several farmers of Noakhali started cultivating cabbage, cauliflower, broccoli and tomato in the small-scale highlands adjacent to homestead. A total of 168 saplings were distributed to enrich agroforestry system with 6 types of fruit trees. Under livestock program, attempts were made to control major diseases of livestock and poultry birds through proper vaccination at the project site for sustaining the production system. Rearing of chicken, duck, turkey and pigeon in households, created a good impact among the farm family especially the semi scavenging system poultry birds rearing. Additional income of Tk. 1500 per month was earned through in house rearing of pigeon. In addition, Napier grass cuttings were also planted in the waste land of homestead or adjacent to homestead to increase fodder production. Highest yield was found from second time harvesting ($7.5-8.1\text{tha}^{-1}$) that meet up requirement their cattle feed as well as additional income by selling fodder in the market. To increase farmer’s income through aquaculture system, fingerlings along with modern improved production system of BFRI was carried during the project periods. Carp polyculture and monosex Tilapia were practiced in seasonal and perennial ponds. Both the system gave higher production and economic return. Furthermore, co-operative farmers were encouraged to manage the pati pata plant occupied in their pond banks or other partially shady places and weaving attractive design Shital Pati in Noakhali site. Several field days program were organized with the participation of adjacent farmers and selected farmers of the project in each location, respectively. For capacity building of the farmers, training programs were also organized with twenty (20) farmers in each training program, on issues that hampered the farming system in the changing climate with their potential remedies.

BRRI Part: A total of twenty-one studies were done for maximizing the total productivity using the existing resources of 12 farmers comprising of 4 from each of marginal, small and medium farmers group. Studies were undertaken including crops, livestock, fisheries and homestead component of farming systems. Most of the farmers usually followed Boro (BRRI dhan28) - Fallow - T. Aman (BRRI dhan49) cropping pattern with rice equivalent yield (REY) of 11.76 t/ha. This pattern was successfully replaced by Mustard - Boro - T. Aman and Boro - Jute - T. Aman cropping pattern with REY of 16.26 t/ha and 20.75 t/ha, respectively. All the tested three cropping patterns gave more than double of REY against the existing Khira- T. Aman (BRRI dhan49) cropping pattern with REY of 13.19 t/ha. In development of high intensive alternate cropping pattern, Khira + Pumpkin - Jute - T. Aman pattern produced more than three times higher REY (35.87tha^{-1}) over existing Boro - Fallow - T. Aman cropping pattern. To fine tuning and disseminate farming systems technologies, year-round vegetables production program was under taken around the homestead and nearby homestead area. Modified Laudove model was followed for homestead area. The average increment of total vegetables production around homestead area was 245 Kg per family and average increment of total income per family was 71.30%. Although in a nearby homestead, the average increment of total vegetables production was 2257 Kg per family with average increment of total income per family was 282%. In production program, six new T. Aman and six new Boro rice varieties were introduced in the study area. Farmers were highly appreciated BRRI dhan75 and BRRI dhan87 for T. Aman, BRRI dhan67 and BRRI dhan81 for Boro season. In poultry rearing, Sonali chicken and Khaki Campbell duck under semi-scavenging system seems to be a good option to increase farmers’ income especially woman financial strength and empowerment also. Sequentially, egg consumption, selling and distributions were also increased per family. The average gross margin increased from Tk. 3622 to Tk. 5403

per farmer from Sonali chicken rearing of the cooperative farmers. In Khaki Campbell duck rearing, average number of eggs laid per month per bird was 115 with the highest number of eggs was 168. Turkey rearing provided good opportunity to income generation with annual average gross margin of Tk. 5360 per family in the first two years of intervention. Although turkey (egg and meat) price and demand were sharply declined in the third year due to farmers poor economic condition to buy a large sized turkey. In livestock system about Tk. 5407 farmer⁻¹ gross margin was obtained through goat rearing. Vaccination program for livestock and poultry birds were undertaken to reduce the mortality rates. The BCR for fish polyculture in Gher system increased from 2.11 at before intervention to 2.18 at after intervention. From fish polyculture in mini pond, the BCR increased from 1.88 at before intervention to 2.06 at after intervention. Mini orchards of mango, ber and litchi were established in nearby homestead with integration of vegetables production. A total of 62 mangoes, 18 elephant foot apple, 75 areca nut, 14 ber, 16 litchi and 28 guava saplings were distributed among 42 farmers for homestead fruit tree plantation. Integrated fish-rice-vegetables production system increased the total productivity of Gher system with annual average gross margin of Tk 348601 per ha. Several matured technologies of NARS were introduced to improve the productivity at the FSRD site, Kaliganj, Satkhira during the sub-project period.

BINA Part: Integrated farming system approach was introduced for homestead vegetables and fruits production, improved cropping pattern, livestock like duck rearing, pigeon rearing, Sonali chicken rearing, turkey rearing, beef fattening, vaccination of poultry birds and animals, fish polyculture, fruits sapling distribution and off-farm activities. Through the sub-project activities, integrated farming system Crop + Livestock + Poultry + Fisheries + Vermicomposting + Household was developed. Vegetables and fruits were grown at the homestead and adjacent to homestead area following BARI developed vegetables production model. Cropping system at the coastal area was improved by developing cropping pattern and crop production through selecting suitable crop varieties and technologies to get higher production and better economic returns. Through integrated farming system, this project has introduced livestock programs like Sonali chicken rearing, pigeon rearing, beef fattening. On Farm composting and off-farm activities were also conducted as environment aspect and to improve family income. Results of the project activities indicated that maximum gross margin was incurred from Mustard-Boro-T. Aman cropping pattern which was estimated Tk. 147778 ha⁻¹. Net income was increased from vegetables Tk. 211.91% and 174% from fruits. Livestock activities like beef fattening, chicken rearing, pigeon rearing incurred a total of Tk. 264150. From fisheries component Tk.197261 was earned annually. Through other activities like composting and off-farm activities, each farmer earned on an average Tk. 15640. The results clearly indicated that the sub-project improved the livelihood of the participating farmers. It was observed from three years result that integrated farming system intervention is profitable. Effective and sustainable integration was observed in the Crop + Livestock + Poultry + Fisheries + Vermicompost+Homestead farming system which increased the net income and employment of farm family.

Keywords: Climate resilient, Farming System Research, Farm productivity, Homestead area, Cropping pattern, Intercropping system, Moringa, Mini orchard, Food security, Homestead model, Integrated farming, Livelihood, Coastal area, Gher system, Gher dyke, Sonali chicken, Khaki Campbell, Turkey, and Fish polyculture.

PBRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. Title of the PBRG sub-project: Climate Resilient Farming Systems Research and Development for the Coastal Ecosystem

2. Implementing organization:

Bangladesh Agricultural Research Institute, Joydebpur, Gazipur

Bangladesh Rice Research Institute (BRRI), Regional Station, Satkhira

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4. Sub-project budget (Tk.):

4.1 Total (in Tk. as approved): 36000000

4.2 Latest Revised (if any): 33662000

5. Duration of the sub-project:

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

5.2 End date: January 2022

6. Background of the sub-project:

About a million hectare (over 30% cultivable area) land of Bangladesh is in the coastal region and is planted with transplanted aman rice of which about 0.83 million hectare is affected by varying degrees of soil salinity (Karim, *et al.*, 2010). These saline soils are distributed sporadically in 64 upazilas of 13 coastal districts covering parts of 8 agro-ecological zones of the country (Ahsan and Sattar, 2009; MOE, 2009). The coastal zone of Bangladesh is prone to multiple threats such as cyclone, storm surges and floods as well as earthquakes, tsunamis, and above all climate changes. Scarcity of drinking water, degradation of land, riverbank erosion, siltation, salinity intrusion, the high ground water arsenic content (Islam and Ahmad, 2004), water logging, water and soil salinity and various forms of pollution have also slowed down social and economic development (Sattar, 2002; Sattar and Mutsaers, 2004). The severity of salinity problem has increased over the years and expected to increase in the future due to sea level rise. Even in non-cyclonic situation, higher mean sea levels are going to increase the problem of coastal flooding and salinization causing significant pressure on livelihood activities. Impact of climatic changes is resulting in increased marginalization of the coastal farmers. Therefore, livelihoods of the coastal farmers must have to be improved with various adaptation and coping mechanisms in order to be able to cope up with the dire consequences of the climatic changes (Gwambene, 2007).

The food production does not seem to have a better future in the event of climate change. In Bangladesh rice production may fall by 10% and wheat by 30% by 2050 (IPCC, 2007). Cropping intensity in the coastal areas is far below those achieved elsewhere in the country (Petersen and Shireen, 2001). The coastal area is deficit in vegetable production and thus malnutrition is widespread among the landless, marginal, and small categories of farmers. In the coastal region, especially in tidal submerged areas; cultivation of vegetables is difficult to some extent because of water stagnation caused by tidal water. Under this situation, homestead vegetable production may be an alternate option in reducing malnutrition and to create job opportunity for women. One of the economic activities in the coastal ecosystem is aquaculture. A vast network of river systems, beels, haors, floods and ponds provide opportunities for both capture and culture fishes. The main land uses are pond aquaculture and shrimp farming. But in these ponds' fishes are not cultivated scientifically. Most of the cattle are poor health due to worm and poor feeding. Besides, a large number of chicken and ducks die every year from different kinds of infections and non-infectious diseases. Through application of appropriate technology in right time and by creating awareness among the farmers, productivity of this sector could be improved. So a single enterprise is not enough for 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). Furthermore, lack of appropriate extension programs for up scaling of improved technologies developed by different NARS institutes is also a hindrance in the coastal region. BARI, BRRI and BINA have already developed some salt tolerant crop varieties (rice, wheat, pulses, oilseed, and vegetables). Besides, BFRI has recommended rice-fish culture suited to the coastal area which needs to be validated and disseminated to the disadvantageous areas to increase productivity and farmers' income.

7. Sub-project general objective:

Maximizing farm productivity with efficient use of farm resources

8. Sub-project specific objectives

BARC Component:

- I. To coordinate and monitor FSRD activities of the partner institutes
- II. Strengthening linkage with the stakeholders in terms of FSRD activities.

BARI Component:

- I. To develop of integrated farming technologies to maximize farm productivity and efficient use of resources.
- II. To modify/fine tune on-station technologies generated by NARS institutes at different FSRD sites of coastal ecosystems.

II. To integrate component technologies (crops, livestock, fisheries, agro-forestry, and homestead gardening, etc.) for improving farm practices, establish linkage with different stakeholders.

BRRI Component:

- I. Generate climate resilient and site specific farming system research and development technologies by optimizing land use for the coastal region of Bangladesh
- II. Disseminate and fine tuning of farming systems and its component technologies to extrapolation domain
- III. Integrate component technologies under specific physical, biological and social environments by efficient use of resources for maximizing farm production.

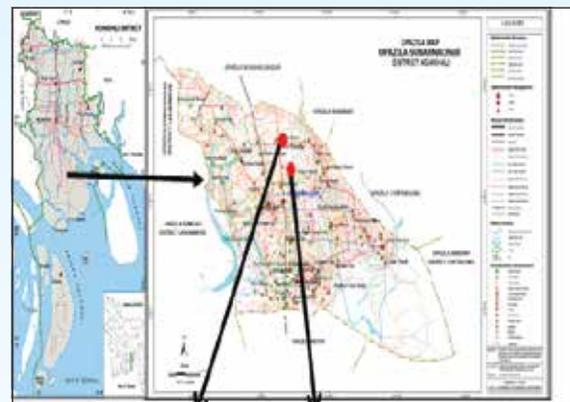
BINA Component:

- I. To maximize the farm productivity with efficient use of farm resources.
- II. To develop climate resilient farming system technologies in the coastal area
- III. To create awareness of improved agricultural technology (ies) among the participating farmers.
- IV. To improve family income and livelihood

9. Implementing locations:

FSRD Site: Subarnachar, Noakhali (BARI)

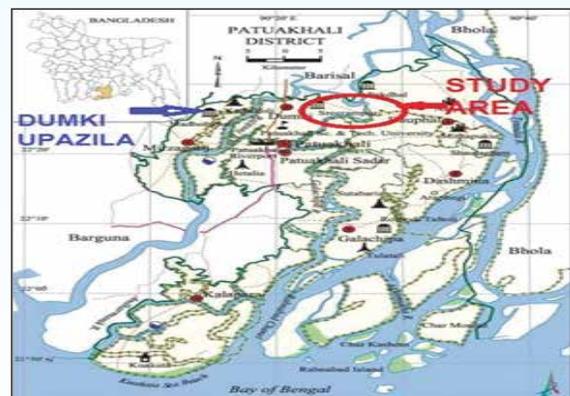
The FSRD site is located about 24 km southern side of Maijdee court, Noakhali at 22° 41' 11" N Latitude and 97° 94' 08" E longitudes. The site represents the vast saline (*Rabi*) and waterlogged (*Kharif II*) area of AEZ 18 (Young Meghna Estuarine Floodplains). The area is situated inside the polder 59/3c of water development board.



Map 9.1. FSRD Site Subarnachar, Noakhali

FSRD Site: Jamla, Dumki, Patuakhali (BARI)

The Farming System Research and Development site is situated at the village Jamla of Dumki upazilla of Patuakhali district located at 22°26' N latitude and 90°22' E longitudes. It is at the south and three Km distance from the Dumki, upazilla and Patuakhali Science and Technology University. It is under coastal area. A small river named Kochabunia runs through the West of the Jamla, FSRD Site. Two narrow canals are running through the FSRD Site. The FSRD Site, Jamla is in coastal areas under AEZ-13. The major soil type is clay to clay loam.



Map 9.2. FSRD site Dumki, Patuakhali

FSRD Site: Kaliganj, Satkhira (BRI)

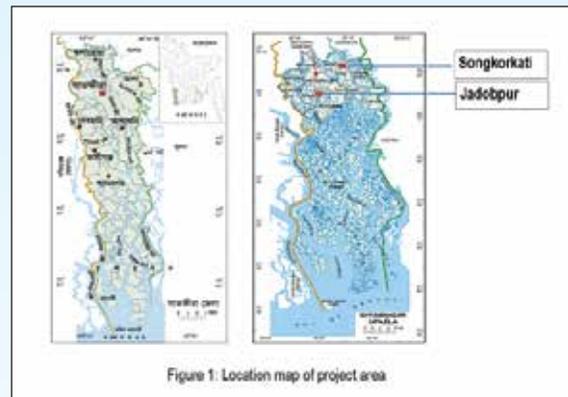
Location of study area is under coastal area named Bishnupur village of Kaliganj Upazila of Satkhira District. The study area is located in between 22°26' 20" and 22°27'50" north latitudes and in between 89° 4' 50" and 89°7'10" east longitudes. Altitude 9 feet to 20 feet above the sea level. The Satkhira district has an area of 3858.33 sq km of which 1534.88 km is under reserve forest. It is bounded by Jashore district on the north, the Bay of Bengal on the south, Khulna district on the east, west Bengal state of India on the West.



Map 9.3. FSRD site Kaliganj, Satkhira

FSRD Site: Shyamnagar, Satkhira (BINA)

Location of study is under coastal area named Jadobpur & Songkorkati village of Shyamnagar Upazila of Satkhira District. The study area is located in between 21°36' and 22°54' north latitudes and in between 88°54' and 89°20' east longitudes. The Satkhira district has an area of 3858.33 sq km of which 1534.88 km is under reserve forest. It is bounded by Jashore district on the north, the Bay of Bengal on the south, Khulna district on the east, west Bengal state of India on the West. Among the seven upazilas of the Satkhira district Shyamnagar is the largest in respect of area (1968.24 sq km). The Coastal area has ecological importance to the climate change.



Map 9. 4. FSRD site Shyamnagar, Satkhira

10. Methodology in brief

The Farming Systems Research and Development Programme (FSRDP) was executed with slightly modified methodology of the Asian Farming Systems Network. The modifications were made to adopt and make it more applicable to Bangladesh condition. For the successful implementation of the proposed Climate Resilient Farming Systems Research and Development for the Coastal Ecosystem program, the following methods were considered.

Specific Methodology

The integrated farming research and development activities were executed under coastal ecosystem at four FSRD sites of three implementing institute BARI, BRI and BINA with the coordination of BARC during February 2018 to January 2022 to improve livelihood of rural households through generation and adoption of Farming System Technologies generated by NARS institutes. The selected FSRD site of different NARS institutes are presented in Table 10.1

Table 10.1. Sub-project locations/sites

SL	Implementing organization	District	Upazila	FSRD Site
1.	OFRD, BARI, Patuakhali	Patuakhali	Dumki	Jamla
2.	OFRD, BARI, Noakhali	Noakhali	Subarnachar	Subarnachar
3.	BRRI, Satkhira	Satkhira	Kaliganj	Bishnupur
4.	BINA, Satkhira	Satkhira	Shyamnagar	Sonkorkati and Jadobpur

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 were followed for successful implementation of integrated farming system research and development program. Site selection was done on the basis of climatic, edaphic, social, vegetation and economic conditions to work as representative site of the regions. Site includes geographical location, physical, biological, social and economic, infra-structural, existing farming systems, resource situation, general problems etc. Detailed survey, case studies, participatory rural appraisal, exploratory survey, different meetings/workshops were conducted with different organizations like UECC/DTC/DECC/ATC, DAE. Different regional and central review meetings and workshops of research institutes, personal observations etc. were also done.

The program was executed in a participatory approach, where critical inputs and technological suggestions were provided by BARI, BRRI and BINA 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 farmer. According to the aim of the project 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 farmer's information of different FSRD sites.

FSRD site	Categories	No. of Farmer	Av. family size (no.)	Av. crop land size (ha)	Av. homestead area (ha)	Av. pond area (ha)
Subarnachar, Noakhali	Marginal	4	5.2	0.19	0.048	0.035
	Small	4	5.75	0.64	0.062	0.065
	Medium	4	5.25	1.25	0.075	0.165
Jamla, Patuakhali	Marginal	5	5.0	0.30	0.085	0.011
	Small	4	4.5	0.50	0.170	0.024
	Medium	3	4.33	1.01	0.101	0.027
Kaliganj, Satkhira	Marginal	4	4.75	0.16	0.053	-
	Small	4	5.50	0.70	0.105	0.040
	Medium	4	4.0	1.24	0.175	0.53
Shyamnagar, Satkhira	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

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.

During the implementation period of the sub-project activities, working group meeting, PRA, base line survey, field visit was done, and field staffs were organized. FSRD team facilitated the cooperators for technological intervention to maximize the productivity of the components. 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

Homestead area is a valuable asset for the farm household in the light of changing climatic conditions which is suitable for production of different kinds of vegetables depending on the availability of different niches (Ferdous, *et al.*, 2016). In the coastal areas, the homesteads are often on raised lands and small where the potentiality of home gardening is limited to some extent. However, homestead areas at coastal ecosystem are more diverse and heterogeneous due to spatial soil variability (slightly to moderately soil salinity), lack of open sunny space, plantation of different kinds of trees haphazardly creates shady conditions, presence of coarse soil or lowlands raised by sands, etc. Moreover, models are dynamic which subjected to changing in socio-economic, environmental contexts and risks rather than static. Considering the above facts, vegetables production models were modified by replacing the top-down transfer of technology models with participatory technology model along with farmers' choice, nutritional aspects, market demand and agro-ecological suitability of the crops.

Vegetables:

10.1. Year-round vegetables and fruit production in homestead

Different models for vegetables and fruit production in homestead area in different farming system research and development (FSRD) sites under coastal land ecosystem are given bellow:

10.1.1. Modified Atkapalia model (BARI, Noakhali)

Modified Atkapalia model followed for year-round homestead vegetables and fruit production at FSRD Site: Subarnachar, Noakhali, under coastal ecosystem. In "Modified Atkapalia model", a total of nine niches were used instead of previously used seven niches. (Table 10.3).

Table 10.3. Modified Atkapalia model (BARI, Noakhali)

Niches/Spaces		Year-round homestead vegetables patterns		
		<i>Rabi</i>	<i>Kharif I</i>	<i>Kharif II</i>
Open sunny spaces	Bed-1	Cauliflower	Brinjal-Gimakolmi	Brinjal-Gimakolmi
	Bed-2	Broccoli	Okra	Okra
	Bed-3	Cabbage	Amaranth / Indian Spinach	Indian Spinach
	Bed-4	Brinjal + Red amaranth	Muki Kachu	Muki Kachu
	Bed-5	Tomato + Radish	Patshak/Indian spinach	Patshak/Indian Spinach

Niches/Spaces	Year-round homestead vegetables patterns		
	<i>Rabi</i>	<i>Kharif I</i>	<i>Kharif II</i>
Fence	Yard long bean/Bitter gourd/Summer country bean		
Roof top	Bottle gourd - Ash gourd/Indian spinach		
Pond banks/Trellis	Country bean/Bottle gourd/Sweet gourd/Bitter gourd, Bamboo, Pigeon pea, Neem		
Unproductive Tree support	Potato Yam/ snake gourd/Ribbed gourd		
Partial shady area	Ginger/Turmeric		
Marshy land	Panikachu		
Homestead boundary	Naga morich, Papaya, Elephant foot Yam, Coconut, Betelnut, Banana, Neem		
Backyard/waste land	Elephant foot Yam, Papaya, Drumstick, Malta, Banana, Neem, Muki kachu		

Partial replacement of leafy vegetables (lalshak, batishak, spinach) and root crops (radish) to high value crops (cauliflower, cabbage, broccoli, brinjal) during *Rabi* season. The leafy vegetables cultivated within the inter space of the high value crops.



Picture 10.1. Atkapalia model (i to iii) and modified Atkapalia model (iv to vi) followed year-round vegetables production at FSRD site, Noakhali (2018- 2020)

10.1.2. Modified Lebukhali Model (BARI, Patuakhali)

Modified Lebukhali model followed for year-round homestead vegetables and fruit production at FSRD Site: Jamla, Dumki, Patuakhali under coastal ecosystem. In “Modified Lebukhali model”, a total of five niches were used instead of previously used seven niches. Fence, shady place, and marshy land niches were held as additional due to unavailable in all the homestead. Nearby fallow space was incorporated in the model that was used as Sorjan and raised bed system of vegetable production (Table 10.4).

Table 10.4. Modified Lebukhali Model (BARI, Patuakhali)

Niche/space		Year-round homestead vegetable pattern		
		<i>Rabi</i>	<i>Kharif I</i>	<i>Kharif II</i>
Open sunny space	Bed-1	Tomato + Spinach	Indian Spinach	
	Bed-2	Brinjal + Red Amaranth	Kangkong	
	Bed-3	Nolkhol + Coriander leaf	Stem Amaranth	Okra
	Bed-4	Cauliflower + Spinach	Okra	Red Amaranth
	Bed-5	Radish + Red Amaranth	Stem Amaranth	Red Amaranth
Trellis		-	-	Ribbed gourd /Snake gourd
Non-fruit trees		-	Sponge gourd/Yam	Sponge gourd/Yam
Pond/ditch slope		Bottle gourd/Sweet gourd	Bitter gourd	
Nearby homestead		Tomato+ Red Amaranth	Bottle gourd	

10.1.3. Modified Laudove Model (BRRI, Shatkhira)

Year round vegetables production was conducted at the FSRD Site Kaliganj, Shatkhira during 2018-2021. BARI developed 'Laudove' model was followed for year-round homestead vegetables and fruit production at FSRD site by twelve farmers with some modification according to the choice of farmers and suitability of coastal area. The crops were selected for different production unit according to the model with some modification based on farmer's choice and preference. However new varieties and crops were also included after getting consent from farmers. The area of each homestead was about 3-4 decimal. Laudove model includes eight production units (10.5).

Table 10.5. Modified Laudove model followed at FSRD Site: Kaliganj, Shatkhira (BRRI)

Sl. No.	Spaces	Cropping Pattern			
		Production unit	Rabi	Kharif-1	Kharif-2
1.	Open Space	Bed 1	Knolkhol	Kangkong	Kangkong
		Bed 2	Beet	Ladies finger Red Amaranth	Ladies finger
		Bed 3	Spinach	Indian spinach	Indian spinach
		Bed 4	Tomato	Stem Amaranth	Stem Amaranth
2.	One tree support	Potato yam/Chui jhal			
3.	House roof	Bottle gourd/Sweet gourd	White gourd	White gourd	
4.	Trellis	Bottle gourd/Country bean	Bitter gourd	Snake gourd	
5.	Partial shady area	Moulavi kochu/ Helencha/Thankuni			
6.	Marshy land	Panikachu	Panikachu	Panikachu	

Sl. No.	Spaces	Cropping Pattern		
7.	Home boundary/backyard	Banana/Moringa		
8.	Home boundary fence	Country bean	Yard long bean	Sponge gourd

10.1.4. Modified Laudove Model (BINA, Shatkira)

Year round vegetables production was conducted at the FSRD Site Shyamnagar, Satkhira during 2018-2021. BARI developed 'Laudove' model was followed for year-round homestead vegetables and fruit production at FSRD site by twelve farmers with some modification according to the choice of farmers and suitability of coastal area. The crops were selected for different production unit according to the model with some modification based on farmer's choice and preference. However new varieties and crops were also included with consent of farmers. The area of each homestead was about 3-4 decimal. Laudove model includes eight production units (Table 10.6)

Table 10.6. Modified Laudove model followed at FSRD Site: Shyamnagar, Shatkira (BINA)

Space		Rabi	Kharif I	Kharif II
		October- March	April-June	July-September
Open sunny space	Bed-1	Red Amaranth (Local)	Red Amaranth	Indian spinach (Local)
	Bed-2	Spinach	Okra (Hybrid)	Coriander
	Bed-3	Cabbage (Tropicsun)	Amaranth	Brinjal (Sada makra, Venar)
	Bed-4	Cauliflower (white marble)	Elephant foot taro (local)	Elephant foot taro (local)
	Bed-5	Knolkhol		
One tree support		Chuijhal		
House Roof		Bottle gourd (Local)	White gourd (Hybrid)	White gourd (local)
Trellis			Bitter gourd (Hybrid)	
Partial shady area		Leaf aroid (Moulavikachu)		
Marshy land		Panikachu (BARI Panikachu-1)		
Home Boundary/backyard		Papaya (Hybrid)		
Home Boundary Fence			Yard long bean (Hybrid)	Sponge gourd (Hybrid)

Vegetables from different beds and niches were harvested according to their maturity and data were recorded. Data on yield, consumption, distribution and selling of different types of vegetables were collected by using a predesigned schedule and through continuous monitoring. The produce values were calculated with the local market price for all crops. The average data were used for interpretation of the result. Cost and returns were also analyzed.



Picture 10.2. Homestead vegetables production at FSRD site Shyamnagar, Shatkhira

10.1.5. Summer Tomato Production in the highlands adjacent to homestead at FSRD site: Subarnachar, Noakhali (BARI)

Three varieties of summer tomato were cultivated among three farmers (one from each group of farmers) during *Kharif* season, 2019. Unit plot size was three decimals (one dec. for each variety). In the *Kharif* season, 2020, one medium category farmer devoted more lands (02 dec) under summer tomato production and total areas were increased. Despite lands, BARI Hybrid Tomato-8 (summer) was used as planting materials in all cases during *Kharif* season, 2020. Fertilizer was applied according to fertilizer recommendation guide (BARC, 2018). The agronomic data are presented (Table 10.7).

Table 10.7. Agronomic practices of Summer Tomato Production at FSRD site, Subarnachar, Noakhali during Kharif season 2019 and 2020

Tomato Varieties	Seedling age (Days)	Spacing (cm)	Date of Transplanting	Fertilizer doses (N-P-K-S-Zn kg/ha)	Date of Harvesting
BARI Hybrid Tomato-8	26 to 27	60 x 40	10 to 14 June 2019	210-105-150-13-2.7	27 July to 17 October 2019
BARI Hybrid Tomato-10					
BARI Hybrid Tomato-11					
BARI Hybrid Tomato-8	24 to 26		24 to 26 June 2020		08 August to 12 October 2020

10.1.6. Winter vegetables cultivation under the shade of summer tomato adjacent areas of homestead at FSRD Site: Subarnachar, Noakhali (BARI)

After cultivation of summer tomato, the existing structure was used to produce early winter season vegetable production in the year among all the farmers. In this case, Cole crops such as cauliflower, cabbage and broccoli were planted under the shade during 25 to 27 October 2019 and 20 to 23 October 2020. It is notable that, winter vegetable production in this area started from last week of November to mid-December, depends on the rainfall. In such cases, seedlings produced from moveable seedbed were used for planting. Moreover, five farmers showed their interest to cultivate winter vegetables in their adjacent lands to homestead (2020-2021) but during (2019-2020) the number was two. More farmers were willing to grow vegetables because of supply of quality seedlings from moveable seed bed and rainfall stop after first week of November, 2020 (Table 10.8). Fertilizer was applied according to fertilizer recommendation guide (BARC, 2018).

10.1.9. Year-round vegetables production nearby homestead area at Kaliganj, Satkhira (BRR) FSRD Site

Two farmers with a total of 60 decimal land areas were selected. During 2019-21, another farmer was added to this program. Improved production practices were tested to increase total vegetables production round the year using existing farm resources. All management practices and fertilizers were used following respective crop recommendation. Data were collected maintaining the standard procedure. Production practices followed during the production period is given in Table 10.11.

Table 10.11. Production practices followed in nearby homestead area at FSRD site, Kaliganj, Satkhira during 2018-21

Sl. No.	Spaces	Cropping patterns
1.	Open land	Cabbage/Spinach - Brinjal – Pumpkin
		Potato/Turnip - Brinjal – Ladies finger/Carrot – Indian spinach/Red Amaranth – Yard long bean/Taro
		Elephant Foot Yam-Tomato/Khira
2.	Stick support	Cucumber - Sponge gourd
3.	Fence/trellis	Bitter gourd -Sponge gourd

10.1.10. Spice's production in the unused shady places of homesteads at FSRD Site: Kaliganj, Satkhira (BRR)

Among the 12 farmers, seven farmers were selected for ginger and turmeric production in shady places and eleven families were motivated for planting Chui jhal spices with the support of perennial trees and nearby walls where nothing else can grow. Management practices followed in this study is shown in Table 10.12.

10.12. Management Practices of Ginger & Turmeric at FSRD site, Kaliganj, Satkhira during 2018-21

Management factors	Ginger	Turmeric
Variety	BARI Ada-2	BARI Holud-4
Seed Rate (kg ha ⁻¹)	2500	2500
Seeding date	26 May-12 April	3-23 May
Spacing (cm×cm)	50 x 25	60 x 25
Fertilizer (kg/ha)*	300-270-230-110-3	220-125-260-110
Weeding	2-3	2-3
Irrigation	1-2	1-2
Pest control	1-2	1-2
Harvesting Date	14 January-3 February	14 January-16 February

* Urea-TSP-MoP-Gypsum-ZnSO₄

Chui jhal plant is one kind of climbing tree that grows in shady places, it was ideal for these kinds of places. Total land area for ginger and turmeric cultivation was 100 m² and 200 m² respectively. After preparing land, ginger and turmeric were sown maintaining 50 cm x 25 cm and 60 cm x 25 cm spacing, respectively. A total of forty one Chui jhal stems were given to eleven farmers during February 2018- January 2019. The size of stems is not marketable during sub-project period but they are growing rapidly in the shady places.

10.1.11. High value vegetables production nearby homestead at FSRD site: Shyamnagar, Satkhira (BINA)

The activity was conducted during 2018-20 at Shyamnagar, Satkhira FSRD Site. In the Rabi season vegetables like cabbage, cauliflower, brinjal, bitter gourd, spinach, broccoli and tomato cultivated followed by watermelon, brinjal, sweet gourd and okra during kharif season. The total size of the plot was

0.62 ha. Previously this land was used for traditional vegetables 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.

Fruits

In the FSRD site mixed mini fruit orchard with Mango, Guava Litchi and Lemon were established. Distributed major fruit sapplings among the cooperators farmers during sub-project period. Irrigation, fertilization, pest control and other management of new and existing fruit trees were undertaken in this program.

10.1.12. Establishment of mini mixed fruit orchard of Mango, Litchi and Ber in homestead at FSRD Site: Kaliganj, Satkhira (BRI)

A total of 75 sapplings of different fruit trees were distributed among the three farmers of FSRD Site, Kaliganj, Satkhira during 2018-2021. The sapplings were mango, litchi and ber. Recommended management practices were followed during plantation of the sapplings.

10.1.13. Development of mini orchard in homestead at FSRD Site: Shyamnagar, Satkhira (BINA)

A total of 875 different fruit sapplings were distributed among the farmers of FSRD Site, Shyamnagar, Satkhira during 2018 - 2020. The sapplings were mango, lemon, elephant foot apple Malta, guava, pumelo, custard apple, sapota, litchi, dragon fruit, emblica, and coconut. Recommended management practices were followed during plantation of the sapplings.

B. Improvement of Crops and Cropping System

10 2. Improvement or development of cropping pattern under coastal ecosystem

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

Table 10.13. Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali (BARI)

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Groundnut	Fallow	T. Aman	Groundnut	T. Aus	T. Aman
Variety		Dhaka-1	-	Sharwna	Dhaka-1	Binadhan-19	BRI dhan87
Date sowing/ Transplanting	2018-19	26-31 Dec.	-	18-20 Aug.	24-26 Dec.	22-24 May	20-22 Aug.
	2019-20	16-18 Dec.		16-22 Aug.	16-17 Dec.	18-22 May	18-19 Aug.
Seed rate ((kg ha ⁻¹))		120	-	42	110	40	40
Spacing (cm)		Randomly	-	Randomly	30×15	20×15	25×15
Fertilizer dose (N-P-K-S-Zn-B kg ha ⁻¹)		20-25-15-0-0-0	-	80-18-20-0-0-0	12-32-42-54-0-2	69-11-38-7-1.9-0	69-22-24-5-4-0

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Groundnut	Fallow	T. Aman	Groundnut	T. Aus	T. Aman
Date of harvesting	2018-19	18-21/4/19		6-8/12/19	19-22/4/19	12-14/8/19	30/11-2/12/19
	2019-20	9-10/4/20	-	5-9/12/20	8-10/4/20	8-11/8/20	23-25/11/20
Field duration (days)		113-115	-	108-110	111-113	80-82	95-100
Turned around time (days)		90-100	-	10-15	20-25	8-10	15-20

Table 10.14. Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali (BARI)

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Soybean	Fallow	T. Aman	Soybean	T. Aus	T. Aman
Variety		Shohag	-	Sharna	BARI Soybean-6	BRRIdhan85	BRRIdhan52
Date sowing/ Transplanting	2018-19	18-22/01/19	-	19-24/8/19	14-20/12/19	20-24/5/19	25-28/8/19
	2019-20	23-25/12/19		20-25/8/20	22-25/01/20	22-25/5/20	24-29/8/20
Seed rate ((kg ha ⁻¹))		55	-	42	45	40	40
Spacing (cm)		Broadcasting	-	Randomly	25×2	20×15	25×15
Fertilizer dose (N-P-K-S-Zn-B kg ha ⁻¹)		20-15-10-0-0-0	-	80-18-20-0-0-0	12-20-22-5-24-1.3	69-11-38-7-1.9-0	69-22-24-5-4-0
Date of harvesting	2018-19	8-15/5/19		8-10/12/19	2-5/5/19	14-16/8/19	5-9/12/19
	2019-20	9-12/5/20	-	10-13/12/20	7-9/5/20	17-18/8/20	8-11/12/20
Field duration (days)		113-117	-	108-110	100-105	85-87	100-110
Turned around time (days)		65-70	-	35-40	30-35	9-12	20-25

Table 10.15. Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali (BARI)

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Fallow	Fallow	T. Aman	Proso Millet	Green Manure	T. Aman
Variety		-	-	Sharna	BARI Cheena-1	<i>Sesbania rostrata</i>	BR23
Transplanting/ sowing Date	2018-19	-	-	19-23/8/19	8-11/1/19	15-17/4/19	19-22/8/19
	2019-20			20-22/8/20	15-17/01/20	18-19/4/20	23-25/8/20
Seed rate ((kg ha ⁻¹))		-	-	42	20	38	40

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Fallow	Fallow	T. Aman	Proso Millet	Green Manure	T. Aman
Date of incorporation	2018-19	-		-	-	4-10/6/19	-
	2019-20			-	-	9-15/6/20	-
Spacing (cm)		-	-	Randomly	Broadcasted	Broadcasted	25×15
Fertilizer dose (N-P-K-S-Zn kg ha ⁻¹)		-	-	80-18-20-0-0	54-24-32-10-1	-	80-19-33-9-4
Date of harvesting	2018-19	-	-	10-14/12/19	5-9/4/19	-	15-20/12/19
	2019-20	-	-	11-14/12/20	8-11/4/20	-	17-23/12/20
Field duration (days)		-	-	108-111	82-85	50-55	115-120
Turned around time (days)		-	-	-	10-15	60-65	20-25

Table 10.16. Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali (BARI)

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Mungbean	Fallow	T. Aman	Potato	Mungbean	T. Aman
Variety		BARI Mung-6	-	Moulata	BARI Alu-73	BARI Mung-6	BRRIdhan 52
Transplanting/ sowing Date	2018-19	3/3/19	-	28/08/19	18/12/18	1/3/2019	28/8/19
	2019-20	1/3/20	-	26/8/20	16/12/19	1/3/2020	25/8/20
Seed rate ((kg ha ⁻¹))		40	-	50	1800	40	40
Spacing (cm)		30×cont.	-	Random	60×25	30×cont.	20×20
Fertilizer dose (N-P-K-S-Zn kg ha ⁻¹)		22-28-22-10-1.8-1	-	110-30-40	150-45-110-16-2.8-1	22-28-22-10-1.8-1	80-28-45-11-3.5-1
Irrigation (DAS)		-	-	-	25 and 45	-	-
Date of harvesting	2018-19	15-20/5/19	-	24/12/19	25/02/19	15-20/5/19	9/12/19
	2019-20	10-15/5/20		20/12/20	26/02/20	10-15/5/20	9/12/20

Table 10.17. Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali (BARI)

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Grasspea	Fallow	T. Aman	Sunflower	T. Aus	T. Aman
Variety		Local	Fallow	Moulata	BARI Surjomukhi-2	BRRIdhan48	BRRIdhan52
Transplanting/ sowing Date	2018-19	16/11/18	-	11/9/19	04/01/19	01/6/19	11/09/19
	2019-20	10/11/19	-	8/9/20	15/01/20	02/6/20	13/9/20

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Grasspea	Fallow	T. Aman	Sunflower	T. Aus	T. Aman
Seed rate ((kg ha ⁻¹))		25	-	50	13	40	40
Spacing (cm)		Continuous	-	Randomly	50×25	20×15	25×15
Fertilizer dose (N-P-K-S-Zn-B kg ha ⁻¹)		13-8-15-0-0-0	-	110-40-60- 25-0-0	90-30-75-30-5-5	70-18-36- 10-10-0	90-20-45- 10-10
Date of harvesting	2018-19	21/03/19	-	26/12/19	11.04.19	03/09/19	24/12/19
	2019-20	24/3/20	-	26/12/20	18.04.20	06/9/20	29.12.20

Table 10.18. Crop management practices of improved and existing cropping pattern during 2018-20 at FSRD site, Kaliganj, Satkhira (BRR)

Observation	Existing cropping pattern		Improved cropping pattern		
Crop	Boro	T.Aman	Mustard	Boro	T. Aman
Variety	BRR dhan28	BRR dhan49	BARI Sarisha-14	BRR dhan81	BRR dhan75
Date of sowing/ Transplanting	10 Jan-7 Feb	5-20 Aug	12-20 Nov	5-10 Feb	1-14 Aug
Seed rate (kg ha ⁻¹)	40	40	6	40	40
Spacing cm×cm)	15×20	15×25	Broadcasting	20×20	20×15
Fertilizer dose (kg ha ⁻¹)*	270-75-90- 60-7.5-0	180-45-60-0- 0-0	54-15-24-10-0-1.7	270-90- 120-90-11- 0	150-52-82- 60-0-0
Date of harvesting	17 May-30 Apr	11-30 Nov	1-6 Feb	12-20 May	1-15 Nov
Field duration (days)	95-105	95-100	75-80	95-100	90-95

*Urea-TSP-MoP-Gypsum-ZnSO₄-Boron

Table 10.19. Crop management practices of improved and existing cropping pattern during 2018-20 at FSRD site, Kaliganj, Satkhira (BRR)

Observation	Improved cropping pattern			Existing cropping pattern	
Crop	Boro	Jute	T. Aman	Boro	T. Aman
Variety	BRR dhan81	NSC	BRR dhan75	BRR dhan28	BRR dhan49
Date of sowing/ Transplanting	05-10 Jan	20-30 April	20-30 Aug	5-15 Jan	05-20 Aug
Seed rate (kg ha ⁻¹)	40	6	40	40	40
Spacing (cm x cm)	20x20	Broadcasting	20×15	15×20	15×25

Observation	Improved cropping pattern			Existing cropping pattern	
	Boro	Jute	T. Aman	Boro	T. Aman
Variety	BRRI dhan81	NSC	BRRI dhan75	BRRI dhan28	BRRI dhan49
Fertilizer dose (kg ha ⁻¹)*	270-90-120-90-11-0	200-50-60-95-11	150-52-82-60-0	270-75-90-60-7.5-0	180-45-60-0-0-0
Date of harvesting	10-20 Apr	10-25 Aug	20 Nov-5 Dec	10-25 Apr	11-30 Nov
Field duration(days)	95-100	110-115	90-95	95-100	96-100

*Urea-TSP-MoP-Gypsum-ZnSO₄

Table 10.20. Crop management practices of improved and existing cropping pattern during 2018-19 at FSRD site, Kaliganj, Satkhira (BRRI)

Observation	Existing pattern		Improved pattern		
	Khira	T. Aman	Khira + Turnip	T. Aman	
Variety	Local	BRRI dhan49	Hybrid	Hybrid	BRRI dhan75
Date of sowing/ Transplanting	8-Dec	10-Aug	12-Nov	10- 11, Dec	30-Jul
Seed rate (kg ha ⁻¹)	1.5	40	0.3	1	40
Spacing (cm×cm)	100×80	15×25	70×80	100×80	20×15
Fertilizer dose (kg ha ⁻¹)	100-40-120-120-0-0	160-45-60-37-0-0	300-250-200-100-0-10	120-50-190-150-0-0	150-52-82-60-11-0
Date of harvesting	10 Feb-10 Apr	24-Nov	2 Feb-30 Apr	10 Feb-30 Mar	5- 7,Nov
Field duration (days)	64-118	104	80-168	60-110	95

*Urea-TSP-MoP-Gypsum-ZnSO₄-Boron

Table 10.21. Crop management practices of improved and existing cropping pattern during 2018-19 at FSRD site, Kaliganj, Satkhira (BRRI)

Observation	Existing pattern		Improved pattern		
	Khira	T.Aman	Broccoli + Pumpkin	T. Aman	
Variety	Local	BRRI dhan49	Hybrid	Hybrid	BRRI dhan75
Date of sowing/ Transplanting	5-Dec	6-Aug	21-Dec	15-Nov	28-30, Jul
Seed rate (kg ha ⁻¹)	1.0	40	0.4	1.5	40
Spacing (cm×cm)	100×80	15×25	50×45	100×80	20×15
Fertilizer dose (kg ha ⁻¹)	100-40-120-120-0-0	170-50-60-40-0-0	250-200-150-0-0-12	120-50-190-150-0-0	150-52-82-60-11-0

Observation	Existing pattern		Improved pattern		
Crop	Khira	T.Aman	Broccoli + Pumpkin	T. Aman	
Date of harvesting	10 Feb-5 April	22- 25,Nov	10 Mar-10 Apr	10 Feb-10 Apr	5- 7,Nov
Field duration (days)	65-120	106	80-110	85-145	95

*Urea-TSP-MoP-Gypsum-ZnSO₄-Boron

Table 10.22. Crop management practices of improved and existing cropping pattern during 2019-20 at FSRD site, Kaliganj, Satkhira (BRI)

Observation	Existing pattern		Improved pattern			
Crop	Khira	T. Aman	Khira + Turnip	T. Aus	T. Aman	
Variety	Local	BRI dhan49	Hybrid	Hybrid	BRI dhan85	BRI dhan75
Date of sowing/ Transplanting	8-Dec	9-Aug	4-Dec	20-Dec	20-22, Apr	20- 21, Aug
Seed rate (kg ha ⁻¹)	1.0	40	1.5	2.5	40	40
Spacing (cm × cm)	100 × 80	15 × 25	100 × 80	30 × 30	15 × 20	20 × 15
Fertilizer dose (kg ha ⁻¹)	100-40-130-110-0-0	17-40-60-40-0-0	120-50-190-150-0-0	300-250-215-0-0-10	135-53-82-0-0-0	150-52-82-60-0-0
Date of harvesting	15 Mar-8 Apr	24-Nov	6 Feb-29 Mar	10-30 Mar	15, Jul	22, Nov
Field duration (days)	67-120	105	62-116	80-100	85	92

*Urea-TSP-MoP-Gypsum- ZnSO₄-Boron

Table 10.23. Crop management practices of alternate cropping pattern and existing cropping pattern during 2018-21 at FSRD site, Kaliganj, Satkhira (BRI)

Observation	Alternatecropping pattern-1				Alternatecropping pattern-2			
Crop	Khira + Pumpkin	Jute	T. Aman		Mustard	Mung bean	Jute	T. Aman
Variety	Hybrid	Hybrid	Rabi-1	BRI dhan75	BARI Sharisa-14	BARI Mung-6	NSC	BRI dhan75
Date of sowing/ Transplanting	7 Nov 2018	18 Nov 2018	7 Apr 2019	2 Aug 2018	18-24 Nov	10-15 Feb	20-21 Apr	14-20 Aug
Seed rate (kg ha ⁻¹)	1.5	5	6	40	6	1	6	40
Spacing (cm)	100 × 80	100 × 80	Broadcasting	20 × 15	Broadcasting	Broadcasting	Broadcasting	20 × 15
Fertilizer dose (kg ha ⁻¹)*	120-50-190-150-0-0	175-175-150-100-12.5-10	200-50-60-95-11-0	150-52-82-60-0-0	54-15-24-10-0-1.7	260-90-120-112-10-0	200-50-60-95-11-0	150-52-82-60-0-0

Observation	Alternatecropping pattern-1				Alternatecropping pattern-2			
Crop	Khira + Pumpkin	Jute	T. Aman	Mustard	Mung bean	Jute	T. Aman	
Date of harvesting	12 Jan-4 March 2019	1 Feb-30 Mar 2019	27 July 2019	31 Oct 2018	2-9 Feb	10-15 Apr	8-12 Aug	12-20 Nov
Field duration (days)	65-117	72-132	110	91	76-77	58-59	109-112	90
Observation	Alternate cropping pattern-3				Existing cropping pattern			
Crop	Cabbage + Spinach		Boro	T. Aman	Boro		T. Aman	
Variety	Atlas	Hybrid	BRR1 dhan81	BRR1 dhan75	BRR1 dhan28		BRR1 dhan49	
Date of sowing/ Transplanting	7-9 Nov	12-15 Nov	12-21 Feb	1-2 Aug	20 Jan-10 Feb		01-05 Aug	
Seed rate (kg ha ⁻¹)	.6	1.5	40	40	40-45		30-35	
Spacing (cm)	60×45	5×5	20×20	20×15	15×20		15×25	
Fertilizer dose (kg ha ⁻¹)*	300 -200-250-0-0-0	180-125-125-0-0-0	270-90-120-90-11-0	150-52-82-60-0-0	260-75-90-60-7.5		160-45-60-45-0	
Date of harvesting	9-28 Feb	8-15 Jan	20-31 May	1-3 Nov	18 Apr-19 May		4-12 Nov	
Field duration(days)	90-109	53-60	97-99	90-92	98-105		94-100	

*Urea-TSP-MoP-Gypsum-ZnSO₄-Boron

Table 10.24. Crop managements of improved and existing cropping pattern at FSRD Site: Shyamnagar, Satkhira during 2019-20 (BINA)

Observation	Existing cropping pattern			Improved cropping pattern		
Crop	T. Aman	Fallow	Boro	T. Aman	Mustard	Boro
Variety	Jamaibabu	Fallow	Binadhan-10	Binadhan-17	Binasarisha-9	Binadhan-10
Date of sowing/ Transplanting	01-07-18/ 30-07-18	-	14-12-18/ 28-01-19	08-07-18/ 30-07-18	10/11/2018	15-12-18/ 28-01-19
Seed rate ((kg ha ⁻¹)	25-30	-	25-30	25-30	7.5	25-30
Spacing	20cm x 15cm	-	20 × 15	20cm x 15cm	Broadcast	20 × 15
Fertilizer dose (N-P-K-S-Zn-B kg ha ⁻¹)	130-170,90-110,35-45,30-35,1.0-4.0	-	210-230,110-120,60-80,45-50,4.0-4.5	120-150,80-100,30-35,25-35,1.0-4.0	190-197,148-155,74-85,100-110,4.5-5.0,9.0-10.0	210-230,110-120,60-80,45-50,4.0-4.5
Date of harvesting (range)	10/11/2018	-	24-04-19	3/11/2018	25-01-19	26-04-19
Field duration (days)	101	-	90	94	76	90
Turned around time (days)	60-65	-	09-12		7	3

10.3. On-farm verification trial at coastal ecosystem

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 duration. To identify the suitable crops and varieties, on-farm verification trial was conducted during years of 2018-19 and 2019-20 with different types of crops. e.g. Boro Rice, Maize, Soybean, Cowpea, Grasspea, Sunflower, Proso millet, Groundnut, Mustard, Potato, Wheat, Chilli and Mungbean etc. The identified suitable varieties were brought under production program at each location in the sub-project period. The details of crop management are given in result part.

Table 10.25. Agronomic practices followed in different On-Farm Verification Trials at FSRD site, Noakhali in coastal ecosystem

Year	Land and Farmers (no)	Name of the Crops	Varieties	Sowing method	Date of sowing	Date of harvesting
2018-2019	270 (6)	Soybean	BARI Soybean-5	Line: 25 cm x 2-3 cm	09 to 14 January, 2019	15 to 22 April, 2019
	70 (1)	Mungbean	BARI Mung-6	Line: 25 cm x 2-3 cm	24 February, 2019	01 - 16 May, 2019
	85 (2)	Cowpea	BARI Felon-1	Broadcasting	08 January, 2019	15 April to 9 May, 2019
	50 (2)	Sunflower	BARI Surjomukhi-2	Line: 50 cm x 25 cm	5 January, 2019	19 May, 2019
	25(1)	Proso millet	BARI Cheena-1	Broadcasting	7 January, 2019	09 April, 2019
2019-2020	22(2)	Potato	BARI Alu-41	Line: 60 cm X 25 cm Using water hyacinth as mulch	8 to 12 December, 2019	4 to 13 March, 2020
	52 (2)	Ground nut	Dhaka-1	Line: 30 cm x 15 cm	12 to 15 January, 2020	25 to 27 April, 2020
	501(9)	Soybean	BARI Soybean-6	Line: 25 cm x 2-3 cm By BPTOS	21 to 29 January	22 April to 5 May, 2020
	225 (6)	Mungbean	BARI Mung-6	Line: 25 cm x 2-3 cm By BPTOS	19 to 24 February, 2020	20 to 23 April, 2020
	93(7)	Cowpea	BARI Felon-1	Line: 40 cm X 10 cm By BPTOS	11 to 15 January, 2020	12 to 17 May, 2020
	20 (1)	Sunflower	BARI Surjomukhi-2	Line: 50 cm x 25 cm	10 January, 2020	25 to 28 April, 2020
	25 (1)	Proso millet	BARI Cheena-1	Broadcasting	18 December, 2019	12 March, 2020
	70 (1)	Mustard	BARI Sarisha-14	Broadcasting	24 December, 2019	9 March, 2020

Year	Land and Farmers (no)	Name of the Crops	Varieties	Sowing method	Date of sowing	Date of harvesting
	100 (1)	Wheat	BARI Gom-25	Broadcasting	9 December, 2019	16 March, 2020
2020-2021	101 (9)	Ground nut	Dhaka-1	Line: 30 cm x 15 cm	5 to 8 January 2021	11 to 17 March, 2021
	30(3)	Potato	BARI Alu-72	Line: 60 cm x 25 cm Using water hyacinth as mulch	12 to 17 December 2020	8 to 15 March, 2021
	300(10)	Soybean	BARI Soybean-5	Line: 25 cm x 2-3 cm By BPTOS	7 to 17 January 2021	20 April to 6 May, 2021
	175(7)	Mungbean	BARI Mung-6	Line: 25 cm x 2-3 cm By BPTOS	28 to 30 January	18 to 23 April, 2021
	110 (7)	Cowpea	BARI Felon-1	Line: 25 cm x 2-3 cm By BPTOS	15 to 17 January 2021	27 to 29 April, 2021
	175(3)	Sunflower	BARI Surjomukhi-3	Line: 50 cm x 25 cm	8 to 17 January 2021	20 to 25 April, 2021
	70 (3)	Proso millet	BARI Cheena-1	Broadcasting	7 to 10 January 2021	11-14 March, 2021
	70 (1)	Mustard	BARI Sarisha-17	Broadcasting	30 December 2021	7 to 12 March, 2021

Table 10.26. Agronomic practices followed in different On-Farm Verification Trials at FSRD site, Patuakhali.

Year	Land size (dec) and farmers (no)	Crops	Varieties	Sowing method	Date of sowing	Date of harvesting/ Present status
2018-2019	100 (3)	Sunflower	BARI Surjomukhi2	Line: 50 cm x 25 cm	7 to 14 Jan, 2019	26 to 28 April, 2019
	200 (5)	Mungbean	BARI Mung-6	Line: 25 cm x 2-3 cm	28 to 30 Jan, 2019	24 to 27 May, 2019
	50 (3)	Maize	BARI Hybrid Maize-9	Line: 60 cm x 20 cm	6 to 8 Jan, 2019	12 to 14 May 2019
2019-2020	52 (9)	Groundnut	BARI Chinabadam-8 & 9 Dhaka-1	Line: 30 cm x 15 cm	14 Jan, 2021	20 to 26 April, 2020

Year	Land size (dec) and farmers (no)	Crops	Varieties	Sowing method	Date of sowing	Date of harvesting/ Present status
	65 (2)	Maize	BHM-9 & 13	Line: 60 cm x 20 cm	15 Jan, 2021	10 to 15 May 2020
	430 (7)	Mungbean	BARI Mung-6	Line: 25 cm x 2-3 cm By BPTOS	18 to 23 Feb, 2020	24 to 27 May, 2020
	65 (1)	Chilli	Local	Line: 50 cm x 40 cm	25 Dec, 2019	15-30 April, 2020
	66 (2)	Groundnut	BARI Chinabadam-8	Line: 30 cm x 15 cm	24 Jan, 2020	12 May, 2020
	40 (5)	Cowpea	BARI Felon-1	Line: 40 cm x 10 cm	24 Jan, 2020	28-30 March, 2020
	33 (1)	Grasspea	BARI Ksheshari-2	Relay with T. Aman	26 Nov, 2019	17-20 March, 2020
	40 (1)	Mustard	BARI Sarisha-14	Broadcasting	28 Dec, 2019	20 March, 2020
2020-2021	52 (9)	G. nut	BARI Chinabadam-8 & 9 Dhaka-1	Line: 30 cm x 15 cm	14 Jan, 2021	28 to 230 April, 2021
	65 (2)	Maize	BHM-9 & 13	Line: 60 cm x 20 cm	15 Jan, 2021	12 to 116 May 2021
	25 (8)	Potato	BARI Alu-28	Line: 60 cm x 25 cm Using water hyacinth as mulch	16 Dec, 2020	10 to 16 March, 2021
	60 (9)	Sunflower	BARI Surjamukhi-2 & 3	Line: 50 cm x 25 cm	02-06 Jan, 2021	25 to 29 April, 2021
	200 (5)	Mungbean	BARI Mung-6 & 8	Line: 25 cm x 2-3 cm By BPTOS	21 Jan, 2021	20 to 26 May, 2021
	73 (4)	Grasspea	BARI Ksheshari-2	Relay with T. Aman	20 Nov, 2020	19-25 March, 2021
	65 (5)	Cowpea	BARI Cowpea-1	Line: 40 cm x 10 cm by PTOS	16 Jan, 2021	27-31 March, 2021
	66 (2)	Chilli	BARI Morich-1	Line: 50 cm x 40 cm	20 Dec, 2020	14-29 April, 2021

10.3.1 On-Farm Verification Trials on different Rabi crops at Farmers field in FSRD sites under Coastal Ecosystem

Table 10.27. Seed rate and fertilizer doses practiced in On-Farm Verification Trials on different Rabi crops at FSRD sites Noakhali and Patuakhali (2018 to 2020)

Crops	Noakhali		Patuakhali	
	Seed rate (kg ha ⁻¹)	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha ⁻¹)	Seed rate (kg ha ⁻¹)	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha ⁻¹)
Boro Rice	28	96-24-30-10-4-0-0	-	-
Wheat	120	110-22-60-15-4-1-0	-	-
Maize	-	-	22	210-30-50-30-0-0-0
Proso millet	20	40-28-60-12-1.5-0-0	-	-
Potato	1600	110-44-120-22-4-1.5-0	-	-
Chilli	-	-	0.8 (for seedling production)	96-66-80-20-0-0-0
Soybean	55	12-20-22-5-24-1.3-0	-	-
Groundnut	115	12-32-42.5-56-1.70-0	120	14-35-45-50-2-0-0
Mustard	10	90-39-42.5-28-1.8-1.3-0	8	90-39-42.5-28-1.8-1.3-0
Sunflower	10	130-48-61-24-2.5-3-7	10	130-48-61-24-2.5-3-7
Mungbean	28	22-28-37-24-3-1.5-0	25	22-28-37-24-3-1.5-0
Cowpea	45	16-20-19-8-0-0-0	48	16-20-19-8-0-0-0
Grass pea	55	20-15 -0-0-0-0-0	50	20-15 -0-0-0-0

10.4. Intercropping system at coastal ecosystem

10.4.1. Intercropping system at FSRD site: Subarnachar, Noakhali under Coastal Ecosystem during 2018-2020 (BARI)

Table 10.28. Agronomic practices of different intercropping system trials at selected farmers field of FSRD site, Subarnachar in Noakhali (2018-2020)

Treatments	Sowing method	Fertilizers doses (N-P-K-S-Zn-B kg ha ⁻¹)	Date of sowing	Harvesting date
Sole Garlic (BARI Rashun-2)	Garlic: 15 cm x 10 cm Cowpea: 30 cm x 10 cm	77-64-90-45-3-3	Garlic: 15 Dec, 18 Cowpea: 15 Jan, 19	Garlic: 2 to 4 Apr., 19 Cowpea: 7Apr. to 3 May, 19
Sole Cowpea (BARI Felon-1)				
Garlic+ Cowpea (1:1)				
Garlic + Cowpea (2 :1)				
Garlic + Cowpea (3:1)				
Garlic + Cowpea (4:1)				

Treatments	Sowing method	Fertilizers doses (N-P-K-S-Zn-B kg ha ⁻¹)	Date of sowing	Harvesting date
Sole Sweet potato (BARI Misti Alu-8) Sole Cowpea (BARI Felon-1) Sweet potato + Cowpea (1:1) Sweet potato + Cowpea (2:1) Sweet potato + Cowpea (3:1) Sweet potato + Cowpea (4:1)	SP: 50 cm x 30 cm Cowpea: inter space between the SP row	105-60-106-20-3-1.5	SP: 12 Dec, 18 Cowpea: 12 Jan, 19	SP: 6 to 8 Apr. 19 Cowpea: 9 Apr. to 1 May, 19
Garlic + Cowpea (3:1)	Garlic: 15 cm x 10 cm Cowpea: 30 cm x 10 cm	77-64-90-45-3-3	Garlic: 20 Dec, 19 Cowpea: 19 Jan, 20	Garlic: 15 April 20 Cowpea: 17 May, 20
Sweet potato + Cowpea (4:1)	Cowpea: inter space between the SP row	105-60-106-20-3-1.5	SP: 15 Dec, 19 Cowpea: 20 Jan, 20	SP: 9 Apr. 20 Cowpea: 21 May, 20

10.4.2. Intercropping systems in Sugarcane at FSRD Site: Kaliganj, Satkhira (BRI)

Table 10.29. Crop managements of intercropping system trials at FSRD site: Kaliganj, Satkhira during 2019-20

Observation	Intercropping system				Sole Sugarcane
	Potato	Turnip	Khira	Sugarcane	Sugarcane
Crop	Cardinal	Hybrid	Hybrid	Chinichapa	Chinichapa
Variety	Cardinal	Hybrid	Hybrid	Chinichapa	Chinichapa
Date of sowing/ Transplanting	24-30 Nov	15-20 Nov	2-9 Dec	16-20 Nov	10-15 Nov
Seed rate (kg ha ⁻¹)	1600	1.5	1.5	2000	2000
Spacing	60cm x45cm	5cmx5cm	100cmx80cm	45cmx22cm	45cmx22cm
Fertilizer dose (kg ha ⁻¹)*	255-125-175-55-0	180-125-125-0-0	120-50-190-150-0	358-275-240-166-7	358-275-240-166-7
Date of harvesting	23-28 Feb	21-25 Feb	10 Feb-14 Mar	15 Oct-13 Nov	10-30 Oct 2020
Field duration(days)	85-90	90-100	68-100	345	345

*Urea-TSP-MoP-Gypsum-ZnSO₄

10.5.1. Integrated Plant Nutrition System (IPNS) and Integrated Pest Management (IPM) approaches in Watermelon cultivation at FSRD site, Noakhali (BARI)

Table 10.30. Management practices followed by the cooperative farmers in watermelon production at FSRD site, Subarnachar, Noakhali during December, 2018 to January, 2021

Varieties	IPNS for HYG (N-P-K-S-Zn-B kg ha ⁻¹ + Cowdung tha ⁻¹)	Sowing/ Transplanting date	Date of establishing pheromone trap	Date of Harvesting
Glory, Sugar Baby, Jumbo, Sweet Jumbo, Glory Jumbo	61-29-11-8.7-1.2-1.2-8	29 December 2018 to 19 January 2019*	25 January to 10 February, 2019	12-22 April
		18 January to 4 February 2020 (Seedlings age- 22 to 25 days)	30 January to 15 February, 2020	10-23 April,
		15 December 2020** and 8 to 15 January 2020	8-9 January 2020**	15-20 April

*Seed was directed sowing on the pit.

** one Medium farmers producing seedlings using seedling trays.

10.5.2. Participatory Variety Selection (PVS) of Aus Rice at FSRD site: Subarnachar, Noakhali (BARI)

During Kharif I season of 2019 and 2020, Participatory Variety Selection (PVS) trials of Aus rice were conducted at FSRD site, Noakhali. For first year trials, four farmers (one from each group of marginal and small whereas two from medium) participated whereas six farmers (marginal farmer-3, small-1, medium-2) were engaged in T. Aus cultivation during the succeeding year. The following were the steps followed in general for the entire Researcher-led On-farm Participatory Variety Selection trials (RPVST).

- Selection of treatments: The numbers of the treatments depend on the amount of particular crop varieties/cultivar seeds available from BRRI, BINA and the target areas. Along with the varietal trials, three cropping systems (dibbling, broadcasting and transplanting) were tested during Kharif season (2019) for better understanding Aus rice production.
- Experimental design: The randomized complete block design (RCBD) was used. The basic unit of replication was a participating farmer at different sites.
- Plot size: The plot size was fifteen (15) decimals per treatment during 2019 and it was twenty (20) decimals per treatment during 2020.
- Field operations: The lands of four (04) trials were prepared by three times ploughing through Sifang power tiller as when the lands turn into optimum conditions for crops establishment. Fertilizers were applied according to fertilizer recommendation guide (BARC, 2018). Crop management practices for researcher led PVS trials were illustrated as follow:

Table 10.31. Crop management practices in the Researcher-led Participatory Variety Selection (RPVS) at FSRD Site Noakhali during Kharif season of 2019 and 2020

Treatments	Seed Rate (Kgha ⁻¹)	Sowing method	Date of Sowing/ Transplanting	Date of harvesting
BRRI dhan48	32	Dibbling (20 cm interval 2 to 3 seeds were placed 4 to 5 cm deep)	11 May 2019	14 August 2019
	80	Broadcasting	13 May 2019	18 August 2019
	45	Transplanting (25 cm x 4-5 cm)	22 May 2019	05 August 2019

Treatments	Seed Rate (Kgha ⁻¹)	Sowing method	Date of Sowing/ Transplanting	Date of harvesting
BRRi dhan48, BRRi dhan82, BRRi dhan83, BRRi dhan85, Binadhan-19	45	Transplanting	26 to 29 May 2019	14 to 17 August 2019
BR26, BRRi dhan48, BRRi dhan83, BRRi dhan85, Binadhan-19, Hydra			19 to 25 May, 2020	6 to 15 August, 2020

10.6. Production program at different FSRD sites under coastal ecosystem during, 2018 to 2020.

10.6.1. Production Program of Aus Rice at FSRD Site: Jamla, Patuakhali (BARI)

Production program of Aus rice was carried out at Jamla, Dumki, Patuakhali during Kharif I season of 2019 and 2020 to study the suitability and varietal performance of modern Aus rice variety in coastal environment. Under production program BRRi dhan 48 was selected in Aus season for medium lowlands of coastal region. The average plot size was 0.17 ha. Fertilizers were applied according to fertilizer recommendation guide (BARC, 2018).

Table 10.32. Crop management practices in the Production program of Aus rice during Kharif season at FSRD site Jamla, Patuakhali

Treatments	Seed rate (Kg ha ⁻¹)	Sowing method	Transplanting Date	Date of harvesting
BRRi dhan48	40 to 42	Transplanting	24 to 28 May, 2019	27 to 30 August 2019
			15 to 20 May, 2020	14 to 16 August, 2020

10.6.2. Production program of T. Aman varieties at FSRD Sites: Noakhali and Patuakhali (BARI)

The activity was conducted at FSRD Noakhali and Patuakhali during 2018-19 to 2020-21. Different modern Aman rice varieties (viz., BR11, BR23, BRRi dhan49, BRRi dhan52 and BRRi dhan76, BRRi dhan87) were used. All the Aman rice varieties were distributed among different categories of farmers for production program. Crops management practices were done according to modern cultivation methods. Average size of the plot according to farm categories and other practices are given in Table 10.33.

Table 10.33. Varieties, farmers categories, plot size, date of transplanting and date of harvesting under production program of T. Aman during Kharif II season of 2018 - 2020 at FSRD site, Subarnachar, Noakhali (BARI)

Year	Varieties	Farm Categories (No.)	Avg. Plot size (dec)	Date of transplanting	Date of harvesting
2018	Sharwna	Marginal (03)	78 dec	16 to 24 August	10 to 18 December
		Small (04)	140 dec		
		Medium (04)	170 dec		
	BRRi dhan52	Marginal (01)	75 dec		
		Small (01)	50 dec		
		Medium (01)	80 dec		
2019	BR23	Marginal (01)	75 dec	23 to 29 August	12 to 16 December
		Small (02)	110 dec		
		Medium (01)	80 dec		
	BRRi dhan52	Marginal (03)	78 dec	19 to 22 August	30 November to 8 December
		Small (03)	130 dec		
		Medium (04)	140 dec		
	BRRi dhan87	Medium (02)	60 dec	17 to 19 August	24 to 25 November

Year	Varieties	Farm Categories (No.)	Avg. Plot size (dec)	Date of transplanting	Date of harvesting
2020	BR23	Marginal (01)	75 dec	20 to 24 August	14 to 19 December
		Small (02)	110 dec		
		Medium (01)	80 dec		
	BRR1 dhan52	Marginal (03) *	95 dec	18 to 20 August	8 to 14 December
		Small (03)	113 dec		
		Medium (04)	124 dec		
BRR1 dhan87	Medium (03)	92 dec	18 to 20 August	24 to 27 November	
	Small (01)	50 dec			

*One marginal farmer rent in 51 dec

Table 10.34. Varieties, farmers categories, area, date of transplanting and date of harvesting of T. Aman rice during Kharif II season of 2018 - 2020 at FSRD site, Patuakhali (BARI)

Year	Varieties	Farm Categories (No.)	Avg. Plot size (dec)	Date of transplanting	Date of harvesting
2018	BR11	Marginal (04)	162 dec	25 to 28 August	01 to 03 December
	BR23	Small (04)	140 dec	04 to 08 September	25 to 28 December
	BRR1 dhan52	Medium (04)	90 dec	05 to 08 September	10 to 12 December
2019	BR11, BR23 BRR1 dhan52	Medium (04)	162 dec	23 to 28 August	3 to 13 December
	BR23 BRR1 dhan52	Small (04)	140 dec	18 to 21 August	7 to 14 December
		Marginal (04)	90 dec		
	2020	BR23	Small (04)	140 dec	20 to 23 August
BRR1 dhan52		Marginal (02)	90 dec		
BRR1 dhan76		Medium (02)	100 dec	22 to 24 August	9 to 12 December
BRR1 dhan49		Medium (02)	62 dec	21 to 25 August	18 to 23 December

10.6.3. Quality seed production of Soybean in Kharif II season at FSRD Site: Subarnachar, Noakhali (BARI)

The trail was conducted at FSRD site, Noakhali during late Kharif II season of 2018-2019 (one small farmer), 2019-2020 (three farmers) and 2020-2021 (three farmers). All fertilizers were applied during final land preparation as 50% of the recommended doses (kg ha^{-1} of N-P-K-S-Zn-B) and Bio-fertilizer (BARI RGM-901) at the rate of 1.2 kg ha^{-1} .

Table 10.35. Agronomic practices followed in quality seed production of Soybean during late Kharif II season for upcoming Rabi season at FSRD site, Noakhali

Years	Avg. Plot size (dec)	Seed rate (kg ha^{-1})	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha^{-1})	Spacing (cm)	Date of sowing	Date of Harvesting
2018-19	10	55	12-20-22-5-2.4-1.3-5	Broadcasting	29 August, 18	17 December, 2018
2019-20	15			Line: 40 cm X 5 cm	19 August, 19	07 to 09 December 2019
2020-21	19				25 August, 20	15 December 2020

10.6.4. Production program of BRR I released T. Aman and Boro rice varieties at FSRD Site: Kaliganj, Satkhira (BRR I)

Twelve new rice varieties were evaluated in different land type at FSRD site, Kaliganj, Satkhira during 2018-20 during in T. Aman and Boro season. Three to six dispersed farmers' fields were taken to validate the field performance of those tested varieties. Each farmer was considered as one replication.

Table 10.36. Farmers number, area, date of of sowing, and date of harvesting of T. Aman rice under production program during 2018-2020 at FSRD site, Kaliganj, Satkhira

Variety	Farmers (no.)	Area (ha)	Date of sowing	Date of harvesting
BRR I dhan52	7	0.94	1-15 July	20 Nov-10 Dec
BRR I dhan71	10	1.34	1 July-3 Aug	27 Oct-10 Dec
BRR I dhan73	18	2.41	2 July-3 Aug	2-23 Nov
BRR I dhan75	25	3.34	2-27 July	23 Oct-20 Nov
BRR I dhan76	5	0.67	7-13 July	10-17 Dec
BRR I dhan87	19	2.54	1-27 July	1-19 Nov

Table10.37. Farmers number, area, date of sowing, and date of harvesting of Boro rice under production program during 2018-2020 at FSRD site, Kaliganj, Satkhira

Variety	Farmers (no.)	Area (ha)	Date of sowing	Date of harvesting
BRR I dhan67	13	1.74	2-13 Dec	22 Apr-5 May
BRR I dhan81	10	1.34	7-27 Dec	26 Apr-15 May
BRR I dhan84	4	0.54	25-30 Dec	27 Apr-5 May
BRR I dhan86	7	0.94	15 Dec-4 Jan	2-30 May
BRR I dhan88	3	0.40	18-22 Dec	3-8 May
BRR I dhan89	2	0.27	27 Dec	25-27 May

10.6.5. Production program of different high yielding crops varieties: Rice, Mustard and Grasspea (BINA)

Under production program, BINA released T. Aman rice (Binadhan-11), Mustard (Binasarisha-4, Binasarisha-9) and Grasspea (Binakheshari-1) were grown by the farmers of the coastal area during 2020 to 2021.

Rice: The rice variety Binadhan-11 was cultivated by four farmers under 1.5 hectare of land. The seeds were sown in 25 July 2020 maintaining line transplanting and harvested on 15-20 November 2020.

Mustard: The mustard variety Binasarisha-4 and Binasarisha-9 were used in this production program. The numbers of farmers were six. The area covered by Binasarisha-4 was 1.5 ha and Binasarisha-9 was 2.0 ha. The seeds were sown in 20- 25 November, 2020 and harvested on 25-28, February 2021.

Grasspea: The Grasspea variety Binakheshari-1 was grown by six farmers which covered two hectare of land under production program. The seeds were sown in 25- 28 November 2020 and harvested on 23-28, March 2021.

10.7. Improvement of productivity in Gher system at FSRD Site: Kaliganj, Satkhira (BRR I)

Seven farmers with non-saline Ghers were selected from the FSRD site, Kaliganj, Satkhira during 2018-20. Improved production technique of fish cultivation in Ghers and different combinations of vegetables on Gher dykes were grown round the year. T. Aman rice BR10, BRR1 dhan30, BRR1 dhan73 were cultivated along with fish. Sole fishes were grown in polyculture system (Silver carp, Catla, Rohu, Mirror carp, Grass carp, Seabass, Greenback Mullet and Corsula Mullet) along with some brackish water species (Coral, Faissa, Khorkhullu) during Rabi season. All management practices and fertilizers were used following respective component. Fish-Rice-vegetables's systems in Gher maximized the resource use efficiency along with the total production and high profit level also.

10.8. Movable seedbed for winter vegetables seedlings production in the highlands adjacent to homestead at FSRD Site: Subarnachar, Noakhali (BARI)

After intervention of the sub- project, it was observed that farmers have been more intending to cultivate vegetables on their high lands or modified land adjacent to homestead than ever before. Meanwhile, lack of early quality seedlings had proven as the major constraints for winter vegetables production in the coastal saline areas of Noakhali. In addition, farmers incapacitated to install permanent structure for seedlings production due to versatile uses of accessible small-scaled high lands, delaying cessation of the monsoonal rainfall and water stagnancy during late *Kharif II* season. Such ecosystem, often called for contemporaneous kind of seedlings production unit that should be portable or moveable. Movable seedbed established at medium high land.

The description of the movable or potable seed bed is given below:

Materials used	Description of the seedbed
<ul style="list-style-type: none"> • Bamboo (27 feet long and 2 pcs) • Muli bamboo (9 feet long and 6 pcs) • Net (5 feet width and 10 feet long with 4"X4" mash) • Polythen (5 feet width and 10 feet long and 80 to 100 mm) • Rope, Nail etc. • Vermicompost (20 Kg) • Coco dust (80 Kg) • Straw (50 Kg) • Jute bag • Fungicide (Provax 200 WP) • Seeds (Respected crops) • Insecticides (for sucking types of insects) • Root promoting hormone (Rooton) 	<p>The seedbed was established in a sunny place where north-south opened alignment was used to minimizing shade and for keeping cool from extra heating through better air circulation. It was four (05) ft wide and eight (8) ft long. Initially, four-bamboo lath (5.5 ft long) was installed in the outer four side of the measured seedbed. Then, the two bamboo laths (six feet) were installed in such a way that each bamboo lath (six feet) was arrayed in the middle position of the two-bamboo lath (5.5 ft) in breadth direction. Also, the lower part of all bamboo laths was buried (0.5 ft) at below the ground. Afterwards, three light bamboo laths (9 ft) were used to keep the structure strong and rigid. In this case, upper ends of two bamboo laths (5.5 ft long) were tied up together by rope with both ends of each nine feet long bamboo lath for connected one-another. Similarly, other bamboo laths (two 5.5 ft and two 6 ft) were tied up with rest of the two nine ft long bamboo laths. Finally, boat-roof shaped roof was prepared where net (6 ft width and 10 ft long with 4"X4" mash) was tied up together with all possible place of the roof by rope. Afterwards, a flat base was prepared (above 2 ft from the ground level) by splitting portion of the bamboo. The distance of the flat base from roof was 3 feet from the corner and 3.5 ft from the middle of roof. After that the flat base was covered by 6 ft width and 8 ft long Polythene sheet (thickness 05 Mils) for constraining any sort of outflow or external damage. Preparation of seedbed media was given below-</p> <ul style="list-style-type: none"> • Composed or wet straw (20 Kg) was distributed just above the plastic covered flat base for heaping up two inches layer. Before using the straw, fungicide or Trichoderma containing organic pesticides should be applied. • Afterwards, composed coco-dust (20 Kg) and vermicompost (15 Kg) was thoroughly mixed up. Major portion (30 Kg) of this mixture was broadcasted all over the straw layer randomly with the help of the hand. The mixture layer was kept 4 to 5 inch in height and the surface was leveled by the piece of flat wood (8 inches long and 6 inches wide). • Then, Provex 200 WP (2 gm per liter water) was applied for controlling soil borne pathogen. After two days of applying Provex, root promoting hormone (Rooton @ 15 gm) was broadcasted equally. • At last, seeds (treated by Provax 200 WP) were sowed in solid line where rows (row-to-row distance two inch) were oriented in north-south direction.



Picture10.4. Moveable seedbed preparation and seedling production

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 & vaccination 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 five major diseases, 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, Hemorrhagic septicemia (HS) vaccine and PPR vaccines were injected as per recommended schedule. Cattle fattening, Calf rearing. Goat and Sheep rearing programs were also conducted at some locations. 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 waste 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 also sold their produced Napier grass in the market besides of feeding their cattle. Poultry rearing is a common practice in rural area of Bangladesh. Poultry disease is the main problem faced by the farmers in poultry rearing. To reduce mortality rate and investigating effectiveness of poultry vaccine at farmers' level. 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. Chicken 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 under homestead area. The carp polyculture (Ahemd and Alam, 1989) and mono culture of Tilapia, Pabda, Shing, Tengra, Koi etc. were cultured in perennial and seasonal ponds more over fish polyculture in saline and non-saline Gher were undertaken at the FSRD sites with the objectives of increasing farmer's income and reducing protein deficiency of rural people. Fish polyculture in saline Gher system was initiated at FSRD site, Kaliganj, Satkhirain 2018. One non-saline and five saline gher were taken in this study. Tiger shrimp (Bagda), Rohu, Catla, Silver carp, Grass Carp, Tilapia, Flathead Grey Mullet (Vangal), Seabass (Coral), Greenback Mullet (Faissa), and Corsula Mullet (Khorkhullu) were cultured in non-saline Gher. The fish culture system was semi-intensive. Overwintered carp fishes and high value fishes like Gulio Catfish (Tengra), Corsula Mullet (Khorkhullu), Flathead Grey Mullet (Vangal) and Greenback Mullet (Faissa) were cultured in the saline Ghers during June-July, when the salinity of Ghers dropped to 3-6 dS/m. For fish culture, 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 (Miah *et al.*, 1997). Fingerling's stocking density is mostly depending on fingerlings size, species, pond depth, feed availability etc. However, in polyculture system, Silver carp, Catla, Rui, Mrigal, Common carp and Mirror carp may release from 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.

E. Off-Farm Activities

Off-farm income refers to the portion of farm household income obtained off the farm, including nonfarm 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. 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. Especially in Noakhali area women were also engaged in weaving Pati (Shitalpati) which was made from *Schumannianthus dichotoma* plant grown at the edges of pond bank under partial shade. Moreover, different types of colour were provided and an informal training were conducted on the design of pati making. At the FSRD Site, Shyamnagar, Satkhira three sewing machines were distributed among the three poor women farmers during 2019-2020. They are using sewing machine for making dresses and other activities according to need by the villagers. Male farmers in this area, are also engaged in Vermi-compost preparation during their leisure periods.

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.

Follow-up evaluation

Follow-up evaluation was continuously made through monitoring of farming systems, cropping systems, the existing technologies and social status (income enhancement, purchasing power, family nutrition, resource pattern, educational facilities for children, medical care, housing status, and improvement of kitchen room and status of farmers in the society etc.) of the farmers. Reasons of change were also monitored along with the farm environment.

11. Results and discussion

11.1. Homestead Production System

11.1.1. Year-round vegetables and fruits production in homestead at FSRD Site: Subarnachar, Noakhali (BARI)

Before intervention of the year-round vegetables production model, farmers of all categories were not aware about proper allocation of the open sunny areas within the same piece of land for different kinds of vegetables throughout the year. Most of them cultivated radish, spinach, red amaranth, and leaf coriander during *Rabi* season whereas few of them planted okra, brinjal, amaranth during *Kharif I* season. On the other hand, jute leaf, Indian spinach and water amaranth was most common vegetables produced by the farmers during *Kharif II* season. Farmers from medium category were able to purchase high value vegetables from market throughout the year to meet up their family needs. Contrary to medium, small and marginal farmers were highly dependent on their production as well as searching vegetables here and there, especially during dry season to wet season. However, small category of the farmers is more versatile for niches utilization (6 niches) followed by medium category (05 niches) and marginal farmers are less than four (4) niches. After intervention of the sub-project, farmers from all categories were able to utilize all the niches that fitted on the particular farmer existing resources. It was evident that the highest amounts of vegetables (434.33 kg/year) were produced by the medium farmer followed by small (351 kg/year) and marginal (295.33 kg/year). Moreover, vegetable production was maximum during *Rabi* season in all categories of farmer and production was below 50% in other two seasons compared to *Rabi* season. Vegetable's production in *Kharif I* season was limited due to high temperature and lack of irrigation facility and sometimes sudden hailstorms. On the other hand, vegetable production in *Kharif II* season was damaged due to high rainfall. In case of medium category, *Kharif II* season (123 kg) was more productive than *Kharif I* season (105.67 kg). On the other hand, vegetables production was slightly higher in *Kharif I* season compared to *Kharif II* season in both marginal and small categories might be due to inclusion of okra and brinjal and other leaf vegetables. In case of all categories of farmers, most productive year was second year of the sub- project and it may be third year after inclusion of final results (Table 11.1).

Table 11.1. Year-round vegetables and fruits production from different niches in different categories of farm households at FSRD Site, Subarnachar, Noakhali during February 2018 - January 2021

Farm category	Spaces		Rabi			Kharif I			Kharif II			Total (Kg)			
			October-January			April-June			July-September			BI	1 st Year	2 nd Year	3 rd year
			1 st Year	2 nd Year	3 rd year	1 st Year	2 nd Year	3 rd year	1 st Year	2 nd Year	3 rd year				
Marginal	Open Sunny Space	Bed-01	28	24	16	3	6	7	13	5	3	129	44	35	26
		Bed-02	11	19	18	9	10	9	11	10	9		31	39	36
		Bed-03	31	27	21	12	12	10	10	12	11		53	51	42
		Bed-04	17	21	14	11	12	8	15	12	8		43	45	30
		Bed-05	21	17	19	0	13	19	0	0	0		21	30	38
	Roof		5	0	0	0	0	5	0	0	3	0	5	0	8
	Trellis		8	31	12	0	6	10	2	2	12	0	10	39	34
	Shady space		4	0	7	5	7	0	7	7	4	0	16	14	11
	Marshy land		0	0	0	0	5	5	0	0	15	0	0	5	20
	Unproductive tree		1	0	0	0	4	10	3	3	8	0	4	7	18
	Fence		0	10	0	0	3	2	2	0	5	0	2	13	7
	Backyard		17	15	9	5	7	8	4	7	5	14	26	29	22
	House boundary		0	12	7	0	4	4	2	3	0	4	2	19	11
		Total (vegetables)	143	176	123	45	89	97	69	61	83	147	257	326	303
	Fruits*	25	34	21	29	37	39	30	45	44	50	84	116	104	
	Total (Vege.+ Fruits)	168	210	144	74	126	136	99	106	127	197	341	442	407	
Small	Open Sunny Space	Bed-01	22	29	22	11	15	8	11	12	11	140	44	56	41
		Bed-02	18	25	16	7	9	24	15	10	8		40	44	48
		Bed-03	27	29	16	8	9	17	10	11	11		45	49	44
		Bed-04	14	22	18	0	9	12	5	3	3		19	34	33
		Bed-05	15	19	14	4	8	9	16	5	5		35	32	28
	Roof		0	0	0	8	5	0	0	10	10	7	8	15	10
	Trellis		13	21	16	0	15	19	9	2	10	25	22	34	45
	Shady space		17	10	7	8	9	5	0	10	3	0	20	22	10
	Marshy land		0	0	0	0	4	17	5	4	4	14	10	15	26
	Unproductive tree		0	4	4	0	2	9	2	2	8	0	2	8	21
	Fence		9	18	7	0	0	2	0	2	5	0	9	20	14
	Backyard		17	22	12	6	6	7	8	1	9	23	31	29	28
	House boundary		12	23	12	0	3	0	0	4	8	9	12	30	20
		Total (vegetables)	164	218	144	52	94	129	81	76	95	218	297	388	368
	Fruits*	39	45	41	43	51	64	47	50	62	89	129	146	167	
	Total (Vege.+ Fruits)	203	263	185	95	145	193	128	126	157	307	426	534	535	

Farm category	Spaces		Rabi			Kharif I			Kharif II			Total (Kg)			
			October-January			April-June			July-September			BI	1 st Year	2 nd Year	3 rd year
			1 st Year	2 nd Year	3 rd year	1 st Year	2 nd Year	3 rd year	1 st Year	2 nd Year	3 rd year				
Medium	Open Sunny Space	Bed-01	26	36	19	9	11	13	14	17	8	210	49	64	40
		Bed-02	25	34	20	3	8	17	17	7	18		45	49	55
		Bed-03	29	39	18	4	6	8	15	9	24		48	54	50
		Bed-04	21	27	19	8	10	19	13	14	14		42	51	52
		Bed-05	18	31	7	20	26	22	22	14	5		60	71	34
	Roof		0	0	0	0	6	0	2	0	0	0	2	6	0
	Trellis		15	36	16	7	8	23	8	10	26	28	30	54	65
	Shady space		11	15	8	4	7	12	5	7	7	15	20	29	27
	Marshy land		5	11	7	0	0	6	2	2	2	0	7	13	15
	Unproductive tree		2	0	0	0	8	3	8	9	16	0	10	17	19
	Fence		3	8	6	0	0	8	0	0	15	0	3	8	29
	Backyard		23	25	16	4	5	12	11	7	7	33	38	37	35
	House boundary		14	27	0	0	12	8	8	3	3	20	22	42	11
	Total (vegetables)		192	289	136	59	107	151	125	99	145	306	376	495	432
Fruits*		33	35	45	41	51	67	50	54	73	105	124	140	185	
Total (Vege.+ Fruits)		224	324	181	100	158	218	175	153	218	411	499	635	617	

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

*Production from betel nut not included here.

In case of fruit production, all categories have coconut and mango plants in their homestead and production was low. However, a few of them have papaya, banana (local) and lemon plants. Under the project support, quick growing fruit trees like papaya and drumstick was provided among the beneficiaries depend on the space of the planting saplings. When the three groups of beneficiaries were compared, the households in the small category produced more fruits in the first year and second year than those in the other categories of participants, but third year medium category households produced more fruits (Table 11.1). The fruit production of small category was highest because of less unproductive trees in the homestead and utilized more niches for papaya plantation. On the other hand, more papaya plants were planted some of supplied fruit trees of the medium category appeared to produce in third year.

After intervention, vegetables and fruit production were increased as well as income in all categories of farmers. As mentioned earlier, farmers existing niches might not be applicable to the “Modified Atkapalia Model” framework which indicated all the niches were not suitable for all the farmers or even in the same category of the farm households. Eventually, the resources variations were reflected from the average vegetables production to average production in each niche across the categories or in the same category. Nevertheless, the most productive unit was open sunny places and minimum in roof top within all farm categories. The average increment over before intervention regarding to production (101 Kg) and income (269%) was highest in marginal category of farm through the average production of vegetables was lower than other categories (Table 11.2). Moreover, the lowest increment was found from medium category of farm which might be due to less gap of production in between before and after intervention in case of most

productive areas. In case of fruit production, the average fruit production was almost similar between medium and small categories, but the average production increment over before intervention was highest (56 kg) in marginal category. Despite fruits production, income increment in fruits was low due to income of betelnut was included in before intervention income. Finally, the total increment of vegetables and fruits production (93 Kg) and income (90%) was observed as highest in marginal category of farm followed by small with 54 Kg and 80 % whereas production 41 Kg and 34% increment were noted in medium category (Table 11.2).

Table 11.2. Year-round homestead production system and income from different niches at FSRD Site, Subarnachar, Noakhali during 2018 to 2021(Avg. of 4 farmers from each category)

Farm Category	Niches	Before intervention		After intervention									
				Year I		Year II		Year III		Average of three year		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 (%)
Marginal	Open sunny place	129	235	192	570	200	784	172	720	188	691.33	45.74	194.18
	Roof top	0	0	5	0	0	0	8	0	4.33	0	-	-
	Trellis	0	0	10	100	39	180	34	400	27.67	226.67	-	-
	Shady place	0	0	16	240	14	186	11	215	13.67	213.67	-	-
	Marshy place	0	0	0	0	5	0	20	150	8.33	50	-	-
	Unproductive place	0	0	4	0	7	0	18	110	9.67	36.67	-	-
	Fence	0	0	2	0	13	150	7	100	7.33	83.33	-	-
	Backyard	14	150	26	240	29	90	22	250	25.67	193.33	83	29
	House boundary	4	50	2	0	19	200	11	135	10.67	111.67	167	123
	Total (Vegetables)	147	435	257	1150	326	1590	303	2080	295.33	1606.67	101	269
	Fruits (other places) *	31	1100	50	1340	47	1310	48	1280	48.33	1310	56	19
Total (Veg.+ Fruits)	178	1535	307	2090	373	2500	351	2970	343.66	2916.67	93	90	
Small	Open sunny place	140	300	183	960	215	1110	194	1280	197.33	1116.67	41	272
	Roof top	7	0	8	0	15	95	10	120	11	71.67	57	-
	Trellis	25	150	22	160	34	280	45	370	33.67	270	35	80
	Shady place	0	0	20	225	22	310	10	350	17.33	295	-	-
	Marshy place	14	30	10	0	15	0	26	120	17	40	21	25
	Unproductive place	0	0	2	0	8	0	21	90	10.33	30	-	-
	Fence	0	0	9	60	20	80	14	70	14.33	70	-	-
	Backyard	23	150	31	200	29	170	28	230	29.33	200	28	25

Farm Category	Niches	Before intervention		After intervention									
				Year I		Year II		Year III		Average of three year		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 (%)
	House boundary	9	90	12	100	30	120	20	100	20.67	106.66	130	19
	Total (Vegetables)	218	720	297	1705	388	2165	368	2730	351	2200	61	206
	Fruits (other places) *	60	1500	70	1690	100	1910	89	1795	86.33	1798.33	44	20
	Total (Veg.+ Fruits)	278	2220	367	3395	488	4075	427	4525	427.33	3998.33	54	80
Medium	Open sunny place	210	740	244	1170	289	1240	231	1150	254.67	1186.67	21	60
	Roof top	0	0	2	0	6	0	0	0	2.67	0	-	-
	Trellis	28	345	30	300	54	440	65	510	49.67	416.67	77	21
	Shady place	15	130	20	220	29	300	27	280	25.33	266.67	69	105
	Marshy place	0	0	7	120	13	160	15	120	11.67	133.33	-	-
	Unproductive place	0	0	10	0	17	60	19	80	15.33	46.67	-	-
	Fence	0	0	3	0	8	50	29	180	13.33	76.67	-	-
	Backyard	33	260	38	315	37	280	35	270	36.67	288.33	11	11
	House boundary	20	150	22	180	42	230	11	50	25	153.33	25	02
	Total (Vegetables)	306	1625	376	2305	495	2760	432	2640	434.33	2568.33	42	58
	Fruits (other places) *	64	1600	69	1620	95	1850	93	1785	85.67	1751.67	34	9
	Total (Veg.+ Fruits)	370	3225	445	3925	590	4610	525	4425	520	4320	41	34

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

*Production and income from betelnut included here.

The quantities of vegetables and fruits consumption, distribution and selling by households in all categories of farmers were significantly increased from before intervention of the “Modified Atkapalia Model”. The consumption picture of homestead produce represents a daily per capita consumption of vegetables and fruits of 146.5 g for marginal group, 165 g for the small group, and 172 g for the medium households. On an average, Bangladeshi people consume a total of 126 g of vegetables and fruit per capita per day which is far below the minimum recommended daily consumption of 400 g of vegetables and fruits (Ali *et al.*, 2008). Moreover, all groups of farmers consumed more than 60% and sold more than 22% of their total vegetables production. The highest gross return and gross margin was obtained from Tk. 12816 & Tk. 9179 year⁻¹ household⁻¹ from homestead of medium farmer & lowest Tk. 8438 & Tk. 5878 was obtained from homestead of marginal farmer (Table 11.3)

Table 11.3. Year-ound vegetables & fruit production system and utilization pattern before and after intervention among different categories of farmers at FSRD Site, Subarnachar, Noakhali during February 2018 to January 2021

Farm Category	Description	Before Intervention		After Intervention					
		Vegetables (kg)	Fruits (kg)	Vegetables (kg)			Fruits (kg)		
				1 st Year	2 nd Year	3 rd Year	1 st Year	2 nd Year	3 rd Year
Marginal	Consumption	108	50	176	221	203	69	89	84
	Distribution	17	10	22	26	25	13	16	14
	Selling	22	53	59	79	75	52	58	54
	Total production	147	115	257	326	303	134	163	152
	Gross return (Tk.)	1771	2615	5140	5385	6515	2520	2930	2825
	Variable cost (Tk.)	485	985	1489	1590	2146	760	820	875
	Gross margin (Tk.)	1286	1630	3651	3795	4369	1760	2110	1950
Small	Consumption	149	63	195	234	226	79	95	104
	Distribution	23	16	28	31	34	31	39	53
	Selling	46	70	75	89	108	89	112	99
	Total production	218	149	297	388	368	199	246	256
	Gross return (Tk.)	2922	3846	5940	6640	6120	4225	4510	3965
	Variable cost (Tk.)	1029	1380	1628	1970	2155	850	1050	1200
	Gross margin (Tk.)	1893	2466	4312	4670	3965	3375	3460	2765
Medium	Consumption	211	80	251	307	271	90	96	119
	Distribution	32	22	42	73	58	28	40	44
	Selling	63	67	83	115	103	83	99	115
	Total production	306	169	376	495	432	193	235	278
	Gross return (Tk.)	3640	4015	7520	8965	7940	4534	4745	4745
	Variable cost (Tk.)	1225	1494	2113	2682	2731	900	1205	1280
	Gross margin (Tk.)	2415	2521	5407	6283	5209	3634	3540	3465

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



Picture 11.1. Year-round vegetables production in different categories farmers homestead at FSRD Site, Subarnachar, Noakhali

11.1.2. Year-round vegetables and fruit production at FSRD Site: Jamla, Patuakhali (BARI)

After intervention vegetables and fruits production among five different niches was increased. vegetables production was maximum during *Rabi* season (91 kg farmer⁻¹) followed by *Kharif II* season across all categories of farmers (Table 11.4). Open sunny spaces were the most productive niches whereas pond/ditch slope gave remarkable yield in all groups of farmers. In case of medium category of farm adjacent highlands near homestead plays a vital role for producing vegetables throughout the year. In case of yearly production, after first year vegetables production increased remarkably in all categories due to addressing the particular niches of that farmers with modern high yielding varieties and management practices. In case of marginal farmers fruits production increased slightly whereas the growth of fruits production in small and medium was quite sharp. Total vegetables and fruit production increased 3 to 4 folds across the farm categories.

Table 11.4. Year-round vegetables and fruits production from different niches in different categories of farm households at FSRD Site, Jamla, Patuakhali

Farm Category	Spaces	Rabi			Kharif-I			Kharif-II			Total (kg)			
		October – March			April - June			July – September			BI	1 st year	2 nd year	3 rd year
		1 st year	2 nd year	3 rd year	1 st year	2 nd year	3 rd year	1 st year	2 nd year	3 rd year				
Open sunny place	Bed 1	8	10	9	8	5	4	12	10	8	10	28	25	21
	Bed 2	8	16	13	6	3	3	10	6	15		24	25	31
	Bed 3	6	12	12	8	9	6	6	9	12		20	30	30
	Bed 4	6	10	8	8	10	4	9	10	10		23	30	22
	Bed 5	6	9	10	7	9	8	04	12	11		17	30	29

Farm Category	Spaces		Rabi			Kharif-I			Kharif-II			Total (kg)			
			October – March			April - June			July – September						
			1 st year	2 nd year	3 rd year	1 st year	2 nd year	3 rd year	1 st year	2 nd year	3 rd year	BI	1 st year	2 nd year	3 rd year
Marginal	Trellis		4	7	7	4	2	8	4	6	10	15	12	15	23
	Non-fruit trees		4	2	4	6	3	5	8	5	6	12	18	10	15
	Pond/ditch slope		32	25	21	5	7	0	15	13	9	35	52	45	30
	Place nearby homestead		0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (Vegetables)		74	81	84	52	48	38	68	71	81	62	194	210	201
	Fruit		0	0	0	24	26	42	0	0	0	18	24	26	42
	Total (vegetables+ Fruits)		74	81	84	76	74	70	68	71	81	80	218	236	243
Small	Open sunny place	Bed 1	10	9	8	5	7	12	14	12	16	20	29	28	36
		Bed 2	9	16	9	12	3	6	10	9	11		31	28	26
		Bed 3	10	10	10	5	9	6	6	4	10		21	23	26
		Bed 4	6	8	8	8	10	10	4	6	8	18	24	28	
		Bed 5	6	6	10	7	9	11	8	6	11	24	21	29	
	Trellis		2	3	2	2	3	4	8	25	29	26	12	31	35
	Non-fruit trees		4	2	4	1	4	2	8	6	19	16	13	12	25
	Pond/ditch slope		65	52	74	0	15	32	111	79	56	42	176	146	162
	Place nearby homestead		104	64	57	0	58	87	30	88	36	28	134	210	180
	Total (Vegetables)		216	170	182	40	118	170	199	235	196	132	458	523	547
	Fruit		0	0	0	35	38	63	7	10	12	22	42	48	75
	Total (vegetables+ Fruits)		216	170	182	75	156	233	206	245	208	154	500	571	622
	Medium	Open sunny place	Bed 1	8	9	12	6	7	7	10	12	12	16	24	28
Bed 2			7	10	11	6	3	5	8	5	8	21		18	24
Bed 3			7	9	10	2	4	4	7	4	7	16		17	21
Bed 4			6	8	8	8	8	4	4	4	7	21		20	19
Bed 5			6	10	13	7	6	7	7	7	9	20		23	29
Trellis		6	5	12	6	7	9	17	14	20	22	29	26	41	
Non-fruit trees		6	2	11	0	0	4	10	7	3	14	16	9	18	
Pond/ditch slope		46	28	121	26	6	0	40	24	15	45	112	58	136	
Place nearby homestead		41	185	62	6	48	15	25	12	78	65	72	245	155	
Total (Vegetables)		133	266	260	67	89	55	128	89	159	162	331	444	474	
Fruit		2	6	5	35	46	82	2	16	18	20	39	68	105	
Total (vegetables+ Fruits)		135	272	265	102	135	137	130	105	177	182	370	512	579	

* 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 followed by place near by the homestead for small and medium group and another promising niche is pond/ditch slopes for all groups of farmers (Table 11.5). After intervention, income from vegetables and fruits was highest (284%) increment was observed in small category followed by medium. The minimum income increment was found in marginal category of farmers due to less land available for vegetables and fruits especially highlands adjacent to homestead about 254% farmer⁻¹. Fruits production from other places of homestead was also increased about 51 kg.

Table 11.5 Year-round homestead production system and income from different niches at FSRD Site, Dumki, Patuakhali during February 2018 to January 2021 (Avg. of 4 farmers from each group)

Farm Category	Spaces	Before intervention		After intervention								
				Feb.2018-Jan.2019		Feb.2019-Jan.2020		Feb.2020-Dec.2020		Avg. Feb. 2018 to Dec. 2020		Avg. Increment (%)
		Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Production (Kg)	Income (Tk.)	Income (%)
Marginal	Open sunny place	10	200	112	2240	140	2800	133	2660	128	2560	1180
	Trellis	15	300	12	240	15	300	23	460	17	340	13
	Non-fruit trees	12	240	18	360	10	200	15	300	14	280	17
	Pond/ditch slope	35	700	52	1040	45	900	30	600	42	840	20
	Place nearby homestead	0	0	0	0	0	0	0	0	0	0	0
	Total (Veg)	72	1440	194	3880	210	4200	201	4020	202	4040	181
	Fruit	18	720	24	960	26	1040	42	1680	31	1240	72
	Total (Veg.+ Fruit)	90	2160	218	4840	236	5240	243	5700	233	5280	144
Small	Open sunny place	20	400	299	5980	124	2400	145	2900	189	3780	845
	Trellis	26	520	12	240	31	620	35	700	26	520	0
	Non-fruit trees	16	320	13	260	12	240	25	500	17	340	6
	Pond/ditch slope	42	840	176	3520	146	2920	162	3240	161	3220	283
	Place nearby homestead	28	560	134	2680	210	4200	180	3600	175	3500	525
	Total (Veg.)	132	2640	634	12680	523	10460	547	10940	568	11360	330
	Fruit	22	880	42	1680	48	1920	75	3000	55	2200	150
	Total (Veg.+ Fruit)	154	3520	676	14360	571	12380	622	13940	623	13560	285
Medium	Open sunny place	16	320	102	2040	106	2120	124	2480	111	2220	594
	Trellis	22	440	29	580	26	520	41	820	32	640	45
	Non-fruit trees	14	280	16	320	9	180	18	360	14	280	0
	Pond/ditch slope	45	900	112	2240	58	1160	136	2720	102	2040	127
	Place nearby homestead	65	1300	72	1440	245	4900	155	3100	157	3140	142
	Total (Veg.)	162	3240	331	6620	444	8880	474	9480	416	8320	157
	Fruit	20	800	39	1560	68	2720	105	4200	71	2840	255
	Total (Veg.+ Fruit)	182	4040	370	8180	512	11600	579	13680	487	11160	176

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

The result indicated that production, consumption of vegetables increased after intervention across all groups and most of the vegetables were sold in nearby market. Small group of farms sold highest (410 kg) amounts of vegetables followed by medium (271 kg) and marginal (160 kg) while consumption increased towards medium to small then marginal. In case of fruits, selling also higher than the consumption among the farmer's categories. The highest gross margin (Tk.11943 year⁻¹) was obtained from small group of farmers followed by medium and marginal group farmers (Table 11.6). The results are in agreement with the findings of Ishtiaque, *et al.*, 2017.

Table 11.6. Year-round vegetables & fruit production system and utilization pattern before and after intervention among different categories of farmers at FSRD site, Patuakhali under coastal ecosystem during February 2018 to January 2021 (Avg. of 04 farmers from each category)

Farm category	Description	Before Intervention		After Intervention					
		Vegetables (kg)	Fruits (kg)	Vegetables (kg)			Fruits (kg)		
				1 st year	2 nd year	3 rd year	1 st year	2 nd year	3 rd year
Marginal	Consumption	25	6	37	45	42	10	12	15
	Distribution	0	0	0	0	0	0	0	0
	Selling	47	12	157	165	159	14	14	27
	Total production	72	18	194	210	201	24	26	42
	Gross return (Tk.)	1440	720	3880	4200	4020	960	1040	1680
	Variable cost (Tk.)	375	0	561	525	629	225	430	575
	Gross Margin	1065	720	3319	3675	3391	735	610	1105
Small	Consumption	45	7	96	120	146	15	18	22
	Distribution	12	0	30	45	35	0	0	7
	Selling	75	15	508	358	366	27	30	46
	Total production	132	22	634	523	547	42	48	75
	Gross return (Tk.)	2640	880	12680	10460	10940	1680	1920	3000
	Variable cost (Tk.)	500	200	1000	950	1200	450	500	750
	Gross margin (Tk.)	2140	680	11680	9510	9740	1230	1420	2250
Medium	Consumption	62	15	124	135	112	20	28	35
	Distribution	15	5	25	20	19	5	5	15
	Selling	83	0	182	289	343	14	35	55
	Total production	162	20	331	444	474	39	68	105
	Gross return (Tk.)	3240	800	6620	8880	9480	1560	2720	4200
	Variable cost (Tk.)	500	250	800	1200	900	500	550	750
	Gross margin (Tk.)	2740	550	5820	7680	8580	1060	2170	3450



Picture 11.2. Year-round vegetables production in different categories farmers homestead at FSRD site, Jamla, Dumki, Patuakhali

11.1.3. Year-round vegetables production in homestead at FSRD Site: Kaliganj, Satkhira (BRR)

Before intervention, the different niches of a homestead area were not used properly. Farmers successively learned to use these niches with the technical help after intervention. The production from different niches after intervention is given in Table 11.7. In the first year of intervention, total vegetables production of nine farmers from different niches of homestead areas was 4410 kg. The production increased to 5487 kg and 5967 kg respectively, in the following two years after intervention (Table 11.7)

Table 11.7. Year-round vegetables production of nine farm households using different niches at FSRD site Kaliganj, Satkhira during 2018-21

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	435	457	462	290	265	271	238	355	382	1033	1077	1115
Roof top	166	176	211	230	204	245	218	260	187	614	640	643
Trellis	218	248	280	186	264	341	165	311	468	569	823	1089
Shady Place	285	513	518	323	345	324	351	542	410	959	1400	1252
Fence	204	211	390	56	240	217	186	266	376	446	717	983
Backyard	46	78	125	138	96	142	165	211	137	349	385	404
House Boundary	26	119	123	185	185	174	229	158	184	440	445	481
Total (vegetables)	1380	1762	2109	1408	1649	1714	1552	2076	2144	4410	5487	5967

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

The gross income from different homestead before intervention was Tk. 61740. Gross income of nine farmers reached to Tk. 88200, Tk. 109740 and Tk. 119340, respectively after intervention 1st 2nd & 3rd year. Average increment of production was 2201 kg and income were 71.3% higher than before intervention (Table 11.8).

Table 11.8. Year-round vegetables production and income of nine farm households at FSRD site Kaliganj, Satkhira during 2018-2021

Niches	Before intervention		After intervention									
			Year I		Year II		Year III		Average of 3years		Average 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	810	16200	1033	20660	1077	21540	1115	22300	1075	21500	265	32.72
Roof top	440	8800	614	12280	640	12800	643	12860	632	12647	192	43.71
Trellis	329	6580	569	11380	823	16460	1089	21780	827	16540	498	151.37
Shady place	711	14220	959	19180	1400	28000	1252	25040	1204	24073	493	69.29
Fence	230	4600	446	8920	717	14340	983	19660	715	14307	485	211.01
Backyard	288	5760	349	6980	485	7700	404	8080	379	7587	91	31.71
House boundary	279	5580	440	8800	345	8900	481	9620	455	9107	176	63.20
Total	3087	61740	4410	88200	5487	109740	5967	119340	5288	105760	2201	71.30

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

Average price (Tk./kg) = 20,

Before intervention, average year-round vegetables production was 343 kg household⁻¹ in similar area. After intervention it increased to 490 kg/65 dec. In the second year of intervention average production of nine farmers was 610 kg/65 dec. In the third year of intervention average production of nine farmers was 663 kg farmer⁻¹. The higher production rate than before intervention consequently trend higher consumption rate of vegetables among nine farmers. In the third year, average consumption farmer⁻¹ was 275 kg. Average vegetables sold increased in three consecutive years.

Disposal pattern of vegetables in homestead are presented in Table 11.9. A total of 1350 kg, 414 kg and 1323 kg vegetables were sold, distributed and consumed, respectively by nine farmers before intervention. After intervention in the first year, a total of 1665 kg, 810 kg and 1935 kg vegetables were sold, distributed and consumed, respectively by nine farmers. The following years, vegetables production and utilization pattern consequently increasing to 2637 kg sold, 855 kg distributed and 2475 kg consumed by the nine cooperative farmers. Gross return before intervention was Tk. 61740 and it was increased Tk. 119340 after three years of intervention. Gross margins of Tk. 77490 were achieved from the production of vegetables in 65 decimal areas after three years of intervention.

Table 11.9. Year-round vegetables production and disposal pattern before and after intervention during 2018-21 at FSRD Site, Kaliganj, Satkhira

Description	Before Intervention	After Intervention		
		Year I	Year II	Year III
Consumption (Kg)	1323	1935	2175	2475
Distribution (Kg)	414	810	810	855
Selling (Kg)	1350	1665	2502	2637
Total production (Kg)	3087	4410	5487	5967
Gross return (Tk.)	61740	88200	109800	119340
Variable cost (Tk.)	22320	29349	38781	41850
Gross margin (Tk.)	39420	58851	71019	77490

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

*Average vegetables price (Tk./Kg) = 20

During the eleven months of last year of intervention (Feb- Jan 2021), vegetables sales and average cash income was increased about 95%, while total income and gross margin was increased about 93% and 97%, respectively over before intervention (Figure11.1).



Picture 11.3. Year-round vegetables production in homestead area at FSRD site Kaliganj, Satkhira

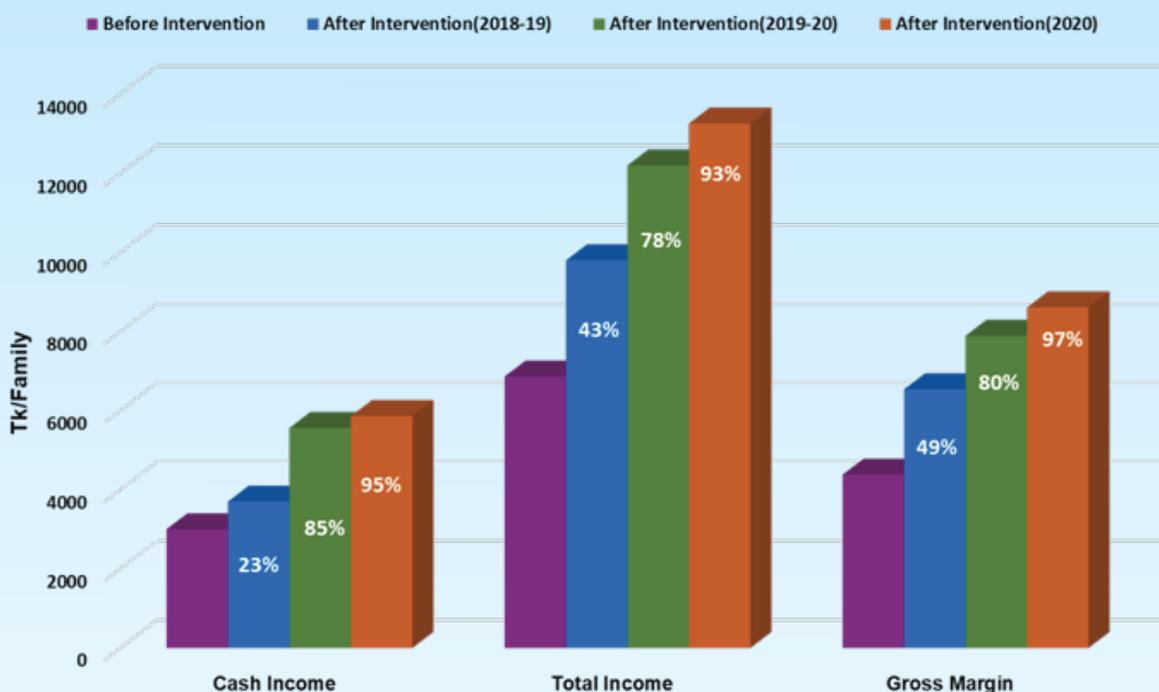


Figure 11.1. Average cash income, total income and gross margin for three years per farm family at FSRD Site, Kaliganj, Satkhira during 2018-21

11.1.4. Year round vegetables production in the homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)

After intervention vegetables and fruits production among nine different niches was increased (Table 11.10). Vegetable production was maximum during *Rabi* season (145 kg farmer⁻¹) followed by *kharif-1* (121 kg farmer⁻¹) and *kharif-2* (120 kg farmer⁻¹). During *Rabi* season, highest yield was found during 2nd year (173 kg farmer⁻¹) followed by 3rd year (156 kg farmer⁻¹). During *kharif-2* season, highest yield was obtained from 2nd year (138 kg farmer⁻¹) followed by 3rd (125 kg farmer⁻¹). During *kharif-1* season, maximum production was found in the 2nd year (141 kg farmer⁻¹) followed by 3rd year (122 kg farmer⁻¹). Fruits production from other places of homestead was maximum was 2nd year (87 kg farmer⁻¹) followed by 3rd year (85 kg farmer⁻¹).

Table 11.10. Round the year vegetables and fruits production from different niches in farmer's household during February 2018 to January 2021 at FSRD site Shyamnagar, Satkhira

Space		Rabi			Kharif-1			Kharif-2			Total		
		October- March			April-June			July-September			(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	8	10	8	10	12	10	8	9	9	26	31	27
	Bed-2	7	9	8	8	11	10	7	10	9	22	30	27
	Bed-3	9	12	10	12	15	13	7	8	7	28	35	30
	Bed-4	5	6	6	12	16	12	12	15	11	29	37	29
	Bed-5	5	8	7	10	11	10	12	16	13	27	35	30
	Roof top	20	35	35	19	30	25	20	26	25	59	91	85
	Trellis	26	45	44	10	15	15	10	19	19	46	79	78
	Shady Place	9	18	14	8	12	11	8	13	13	25	43	38

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
Marshy Land	7	10	9	5	7	5	6	8	8	18	25	22
House Boundary /Backyard	8	14	10	5	8	7	6	10	7	19	32	24
Fence	3	6	5	2	4	4	2	4	4	9	14	13
Total (vegetable)	107	173	156	101	141	122	98	138	125	308	452	403
Fruits	22	40	40	12	22	20	15	25	25	49	87	85
Total (vegetables +fruit)	129	213	196	113	163	142	113	163	150	157	539	488

* 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 (Table 11.11). Most productive unit was open sunny place (147 kg farmer⁻¹) followed by roof top (78 kg farmer⁻¹). Minimum productive unit was backyard (6 kg farmer⁻¹) because farmers were not interested to use it. After intervention income was increased about 211.91% farmer⁻¹. Fruits production from other places of homestead was also increased about 174%.

Table 11.11. Round the year vegetables and fruits production from different niches of homestead at FSRD site Shyamnagar, Satkhira during Feb. 2018 to Jan. 2021 (average of 12 farmers)

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	50	1000	125	2500	168	3360	149	2980	147	2947	194	195
Roof top	28	560	59	1180	91	1820	85	1700	78	1567	17.85	179.8
Trellis	23	460	46	920	79	1580	78	1560	68	1353	195.62	194
Shady place	9	180	25	500	43	860	38	760	35	707	289	292.7
Marshy place	-	-	18	360	25	500	22	440	22	433	100	100
Fence	5	60	9	180	14	280	13	260	12	240	140	300
Backyard	2	40	5	100	7	140	5	100	6	113	200	182.5
House boundary	11	220	19	380	32	640	24	480	25	500	127.2	127.2
Total	128	2520	306	5000	459	9180	414	8280	393	7860	207.03	211.91
Fruit (other places)	27	810	49	1470	87	2610	85	2550	74	2210	174	173
Total	155	3330	355	6470	546	11790	499	10830	467	10070	201.29	202.40

* 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 (Ali et al., 2008). Each farmer on an average produced about 306 kg, 459 kg and 414 kg and sold 173 kg, 302 kg and 258 kg of vegetables at 1st, 2nd and 3rd years, respectively which are much higher than before intervention. At the first year farmers was obtained 49 kg of fruits among which consumed 25 kg, distributed 8 kg and selling 16 kg. At the second year farmers was obtained 87 kg of fruits among which consumed 37 kg, distributed 13 kg and selling 47 kg. Average cost of production per farmer per year was Tk. 1738 and average gross margin from homestead vegetables production was Tk. 6122 (Table 11.12).

Table 11.12. Round the year vegetables and fruits production and utilization pattern before and after intervention during Feb. 2018 - Jan. 2021 at FSRD site Shyamnagar, Satkhira (Average of 12 farmers)

Description	Before intervention		After intervention					
	Vegetables (kg)	Fruits (kg)	Vegetables (kg)			Fruits (kg)		
	2017-18	2017-18	Year I	Year II	Year III	Year I	Year II	Year III
Consumption	70	16	92	105	107	25	37	36
Distribution	12.5	5	41	52	49	8	13	12
Selling	45.5	6	173	302	258	16	47	37
Total production	128	27	306	459	414	49	87	85
Gross return (Tk.)	2560	810	6120	9180	8280	1470	2610	2550
Variable cost (Tk.)	1195	150	1760	1796	1657	442	510	470
Gross margin (Tk.)	1365	660	4360	7384	6623	1028	2100	2080

Vegetables avg. price=20 Tk/kg, Fruits avg. price=30 Tk./kg.

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

11.1.5 Summer Tomato Production in the highlands adjacent to homestead at FSRD Site: Subarnachar, Noakhali (BARI)

Summer tomato was cultivated by the three farmers and four farmers during *Kharif* season of 2019 and 2020, respectively. In the year 2019, among three varieties, the highest yield and gross margin 24.12 t ha⁻¹, and Tk.1026844 ha⁻¹, respectively were obtained from BARI Hybrid Tomato-8 (summer) . In the year 2020 only BARI Hybrid Tomato-8 (summer) was cultivated. The average yield and gross margin were obtained 22.81t ha⁻¹ and Tk.11,19,544 ha⁻¹, respectively (Table 11.13). Although yield was lower in the second year but due to high price of tomato in the market gross margin was higher. Farmers were interested to grow BARI Hybrid Tomato-8 (summer) due to higher yield as well as economic return.

Table 11.13. Average Yield of Summer tomato varieties at FSRD Site, Subarnachar, Noakhali, during Kharif season of 2019 and 2020

Year	Variety	Mean Yield (t ha ⁻¹)	GR (TK.ha ⁻¹)	TVC (TK.ha ⁻¹)	GM (TK.ha ⁻¹)
2019	BARI Hybrid Tomato-8 (Summer)	24.12	2050200	10,23,356	1026844
	BARI Hybrid Tomato-10 (Summer)	20.43	1736550	10,23,356	713194
	BARI Hybrid Tomato-11 (Summer)	19.65	1670250	10,23,356	646894
2020	BARI Hybrid Tomato-8 (Summer)	22.81	21,42,900/-	10,23,356	1119544

*Price (Tk Kg⁻¹): Summer tomato = 85/- (2019), summer tomato = 90/- (2020)

*GR= Gross Return, TVC= Total Variable Cost, GM= Gross Margin



Picture 11.4. Production of different summer tomato varieties at FSRD site Subarnachar, Noakhali during Kharif season of 2019 and 2020

11.1.6 Vegetables cultivation adjacent to homestead at FSRD Site: Subarnachar, Noakhali (BARI)

Farmers cultivated early winter vegetables (cabbage, cauliflower and broccoli) After harvest of summer tomato, in the shed Farmers cultivated early winter vegetables (cabbage, cauliflower and broccoli) The yield and gross margin was recorded higher than the normal winter vegetables as farmers produced it earlier (Salim, *et al.*, 2008). Highest gross margin (Tk. 4,36,296 ha⁻¹) were obtained from cabbage, cauliflower and broccoli during the *Rabi* season of 2020. Lowest gross margin (Tk.2,08,908 ha⁻¹) was found from bitter gourd during *Kharif- I* season of 2020 (Table 11.14).

Table 11.14 Winter vegetables production under the shade of summer tomato and other places near homestead at FSRD site, Subarnachar, Noakhali during 2019 and 2020

Year	Season	Crops	Place of cultivation	Avg. Whole plot Yield (Kg)	GR (TK. ha ⁻¹)	TVC (TK. ha ⁻¹)	GM (TK. ha ⁻¹)
2019	Rabi	Cabbage, Cauliflower (Avg. plot size 3 dec)	Under the shade of previously grown summer tomato	370	5,88,552	1,72,970	4,15,582
2020		Cabbage, Cauliflower, Broccoli (Avg. plot size 3.5 dec)		417	6,09,266		4,36,296
2021		Cabbage, Cauliflower (Avg. plot size 2.5 dec)	Modified land near homestead	351	5,20,182	2,11,854	3,08,328
2020	Kharif I	Bitter gourd	Using the shade as trellis	216	2,66,760	57,852	2,08,908

*Price (Kg per TK.): Cole crops (under the shade): 20 Tk., Cabbage and



Picture 11.5. Vegetables production under the shade of previously grown summer tomato at FSRD Site, Subarnachar, Noakhali

11.1.7. Year-round vegetables production at nearby homestead area at FSRD Site: Kaliganj, Satkhira (BRRI)

Nearby homestead area mostly remains fallow rather to use for vegetables production or farmers are very reluctant to produce vegetables. Therefore, the production and income from vegetables before intervention was very minimum. After intervention farmers started year-round vegetables cultivation in nearby homestead areas. In the first year of intervention (2018-19), total production was 5810 kg. The production increased to 9150 kg and 9675 kg, respectively in the following years of intervention (Table 11.15).

Table 11.15. Year-round vegetables production (kg) nearby homesteads of three different farmers at FSRD site Kaliganj, Satkhira during 2018-2021

Farmers Name	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
Tapoti Bala	1760	1480	1540	485	698	732	595	657	673	2840	2835	2945
Nilufa Yasmin	1560	2160	1865	564	795	810	846	970	980	2970	3925	3655
Masudur Rahman	-	1420	1705	-	430	675	-	540	695	-	2390	3075
Total	3320	5060	5110	1049	1923	2217	1441	2167	2348	5810	9150	9675

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

Gross income from different nearby homesteads before intervention was Tk. 43000. Gross income of three farmers increased to Tk. 116200, Tk. 183000 and Tk. 193500, respectively after intervention of three consecutive years. Average increment of vegetables production was 6052 kg and income were 282% higher compared over before intervention (Table 11.16).



Picture 11.6. Vegetables production nearby homestead at FSRD Site, Kaliganj, Satkhira

Table 11.16. Year-round vegetables production and income from nearby homesteads of three different farmers at FSRD site Kaliganj, Satkhira during 2018-21 (Comparative data)

Farmers' Name	Before intervention		After intervention									
	2017-18		Year I		Year II		Year III		Avg. of three years		Average 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 (%)
Tapoti Bala	570	11200	2840	56800	2835	56700	2945	58900	2873	57467	2303	413

Farmers' Name	Before intervention		After intervention									
			Year I		Year II		Year III		Avg. of three years		Average 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 (%)
Nilufa Yasmin	880	17600	2970	59400	3925	78500	3655	73100	3517	70333	2637	300
Masudur Rahman	710	14200	-	-	2390	47800	3075	61500	1822	36433	1112	157
Gross return	2160	43000	5810	116200	9150	183000	9675	193500	8212	164233	6052	282

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

*Average vegetables price (Tk/Kg) = 20, Total production area = 93 decimal,

Year-round vegetables production and disposal pattern in nearby homestead before and after intervention are presented in Table 11.17. Before intervention, vegetables production nearby homestead was 2160 kg. It was increased to 9675 kg 3rd year of intervention. The average consumption by farmers was 355 kg of before intervention. It increased to 745 kg per farmer at third year of intervention. In the 1st year, a total of 3826 kg, 624 kg and 1360 kg were sold, distributed and consumed from 0.25 ha⁻¹, respectively grown in nearby homestead. After intervention, the production rates gradually increased. At the third year, total 6114 kg, 1326 kg and 2235 kg vegetables were sold, distributed and consumed, respectively grown in nearby homestead. Vegetable's production and consumption rate was consequently increased after intervention. Average vegetables sale also increased in last three consecutive years after intervention. During 3rd year, vegetables sales increased almost 853% higher than before intervention. The increased production subsequently increased vegetables consumption, selling and distribution. Higher consumption ensures better nutritional benefits for the farmers as well as higher selling increased the farmer's income.

Table 11.17. Year-round vegetables production and disposal pattern in nearby homestead before and after intervention at FSRD site Kaliganj, Satkhira during 2018-21

Description	Before Intervention	After Intervention		
		Year I	Year II	Year III
Consumption (Kg)	1065	1360	2145	2235
Distribution (Kg)	375	624	1104	1326
Selling (Kg)	720	3826	5901	6114
Total production (Kg)	2160	5810	9150	9675
Gross return (Tk.)	43200	116200	183000	193500
Variable cost (Tk.)	11880	45550	84740	94290
Gross margin (Tk.)	31320	70650	98260	99210

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

*Average vegetables price (Tk./kg) =20

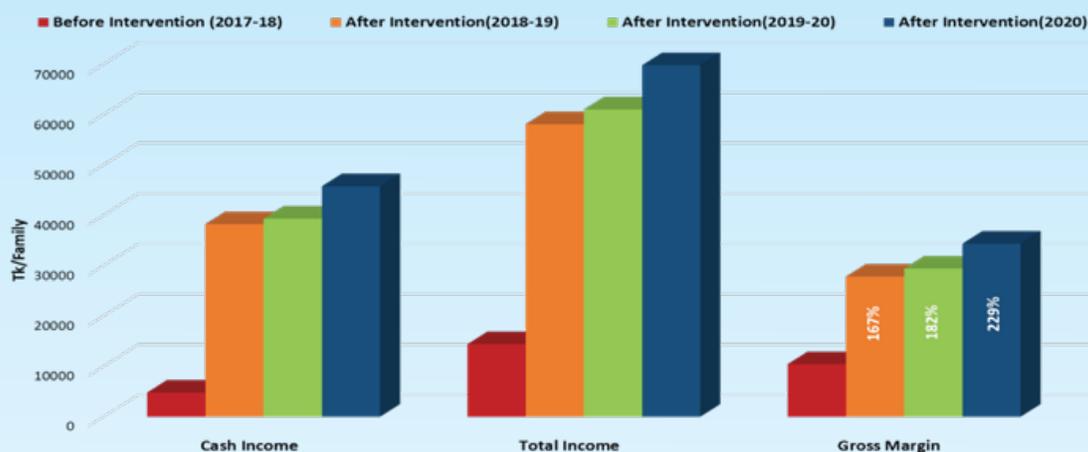


Figure 11.2. Average economic returns from three farmers near by homestead vegetables production at FSRD Site, Kaliganj, Satkhira during 2018-21

11.1.8. High value vegetables production near by the homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)

High value vegetables production trial was conducted near by homestead during 2018-21 at the FSRD Site Shyamnagar, Satkhira. In the *Rabi* season vegetables like cabbage, cauliflower, brinjal, broccoli and tomato were cultivated followed by watermelon, brinjal, sweet gourd, elephant foot yam and okra during *kharif* season. The total size of the plot was 0.62 ha. Previously this land was also used for traditional vegetables cultivation. Seeds of different vegetables and fertilizers were supplied to the farmers. The highest production (13803 kg) was found in *Rabi* season followed by *Kharif II* season (8280 kg) as well as gross margin was Tk. 228373 in *Rabi* season and Tk. 154074 in *Kharif II* season respectively. Before intervention gross margin was Tk. 67519 but after intervention it increased to Tk. 419629 (Table 11.18)

Table 11.18. Yield and economics of high value vegetables production nearby homestead before and after intervention at FSRD site Shyamnagar, Satkhira during Feb. 2018 - Jan. 2021

Name of vegetables	Before intervention (Kg)			After intervention (Kg) Feb 2018 - Jan 2021		
	Rabi	Kharif-1	Kharif-2	Rabi	Kharif-1	Kharif-2
Rabi (Cabbage, Cauliflower, Broccoli, Tomato, Brinjal)	1928			13803		
Kharif-I (Lady's finger, Indian spinach, Cucumber, Sponge gourd, Watermelon)		970			2312	
Kharif-II (Summer tomato, Bitter gourd, Kakuro, Elephant foot yam)			1643			8280
Total production	1928	970	1643	13803	2312	8280
Average total production in Rabi, Kharif-I and kharif-II (Feb 2018- Jan. 2021)	1514			8132		

Name of vegetables	Before intervention (Kg)			After intervention (Kg) Feb 2018 - Jan 2021		
	Rabi	Kharif-1	Kharif-2	Rabi	Kharif-1	Kharif-2
Gross return (Tk.)	57840	29100	49294	414093	69360	248400
Total variable cost (Tk.)	27920	14150	26645	185720	32178	94326
Gross margin (Tk.)	29920	14950	22649	228373	37182	154074
Total Gross margin	67519			419629		

11.1.9 vegetables production in Sorjan bed and raised bed at FSRD Site: Jamla, Patuakhali (BARI)

Vegetables production in Sorjan bed are presented in Table 11.19. During *Rabi* season, total production of sweet gourd was 234 Kg and in *Kharif I* and *Kharif II* bottle gourd production was 295 Kg. Farmer earned gross margin about Tk.11975 from the Sorjan bed during *Rabi* season of 2019-20 and *Kharif* season of 2020.

Table 11.19. Vegetables production in Sorjan bed during Rabi (2019-20) and Kharif (2020) season in farmers field at FSRD Site, Jamla, Patuakhali

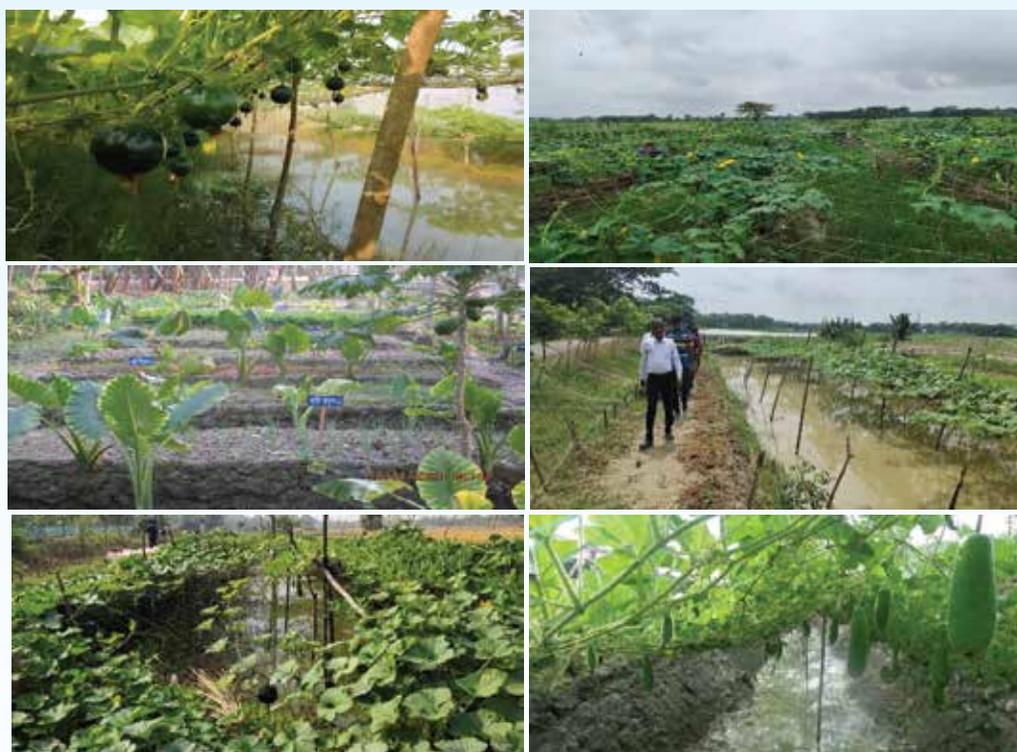
Vegetables	Before Intervention (kg)			After Intervention (kg)	
	Rabi	Kharif 1	Kharif II	Rabi (2019-2020)	Kharif (2020)
Sweet gourd	0	0	0	234	
Bottle gourd	0	0	0	-	295
Total production	0	0	0	234	295
Gross return (Tk.)	0	0	0	7020	6425
Total variable cost (Tk.)	0	0	0	850	620
Gross margin (Tk.)	0	0	0	6170	5805

Vegetables production in raised bed at the field of selected farmers, are presented in Table 11.20. Farmers produced different kinds of vegetables in their raised bed throughout the year where highest (35 kg) yield was found from red amaranth during *Kharif I* season and the lowest (8.0 kg) yield was found from onion during *Rabi* season. The total production was 242 Kg, From the raised bed, farmer earned gross margin about Tk. 5440 which was 210% higher than before intervention during *Rabi* season of 2019-20 and *Kharif* season of 2020.

Table 11.20. Vegetables production in raised bed at selected farmers field of FSRD site, Jamla Patuakhali during Rabi (2019-20) and Kharif (2020) season

Vegetables	Before Intervention (kg)			After Intervention (kg)		
	Rabi	Kharif 1	Kharif II	Rabi	Kharif 1	Kharif II
Red amaranth	-	-	-	35	-	-
Onion	-	-	-	08	-	-
Okra	-	-	-	14	-	-
Bitter gourd	-	-	-	20	-	-

Vegetables	Before Intervention (kg)			After Intervention (kg)		
	Rabi	Kharif 1	Kharif II	Rabi	Kharif 1	Kharif II
Kangkong	-	-	-	-	-	25
Indian Spinach	-	-	-	-	10	18
Papaya	12	25	20	12	32	26
Pani Kachu	-	-	24	-	-	42
Production/Season	12	25	44	89	42	111
Total production /year	81			242		
Gross return (Tk.)	2430			7260		
Variable cost (Tk.)	680			1820		
Gross margin (Tk.)	1750			5440		



Picture 11.7. Vegetables production in Sorjan and Raised bed at FSRD Site, Jamla, Patuakhali

11.1.10. Spice's production in unused shady places of the homestead area at FSRD Site: Kaliganj, Satkhira (BRRI)

Each of the household had some shady areas, where turmeric and ginger were grown and turmeric yielded 19.85 t ha⁻¹, 23.25 t ha⁻¹ and 22.6 t ha⁻¹, respectively during three consecutive years after intervention. Yield of ginger was 8.9 t ha⁻¹, 10.1 t ha⁻¹ and 10 t ha⁻¹, respectively in three consecutive years after intervention. Average production of ginger and turmeric was 9.67 t ha⁻¹ and 21.9 t ha⁻¹, respectively. Total

cost for the production of ginger and turmeric was Tk. 388,000 ha⁻¹ and Tk. 258,333 ha⁻¹, respectively (Table 11.21). The average gross margin Tk. 772,000 ha⁻¹ and Tk. 617,667 ha⁻¹ was found from cultivation ginger and turmeric, respectively.

Table 11.21. Yield, cost and return of ginger and turmeric production at FSRD, Kaliganj, Satkhira during 2018-20

Crop	Yield (t/ha)			Total income (Tk./ha)			Total cost (Tk./ha)			Gross margin (Tk./ha)		
	Feb 18- Jan 19	Feb 19- Jan 20	Feb- Dec 2020	Feb 18- Jan 19	Feb 19- Jan 20	Feb-Dec 20	Feb 18- Jan 19	Feb 19- Jan 20	Feb 20- Dec 20	Feb 18- Jan 19	Feb 19- Jan 20	Feb - Dec 20
Ginger	8.9	10.1	10.0	1068000	1212000	1200000	385000	389000	390000	683000	823000	810000
Turmeric	19.85	23.25	22.6	794000	930000	904000	250000	265000	260000	544000	665000	644000

*Price/Kg (Tk.): Ginger=120, Turmeric=40.

Chui Jhal spices are beneficial for human health which helps in the improvement of immunity and digestion and so on. Traditionally, farmers of this locality are used to chui jhal spices on the boundary wall and perennial tree of homestead. After intervention, farmers were motivated to cultivate Chui jhal vine under shady places rather than boundary wall and perennial tree. A total of 97 vines were planted at 11 homesteads in the year January 2019 and December 2020, respectively (Table 11.22). The Chui jhal vines are growing quickly. The farmers are happy for its quick growth rate. After 2-3 years Chui jhal vine will be ready to sale in the market.

Table 11.22. Number of farmers, number of vine and creeper types for growing Chui jhal spices at FSRD site, Kaliganj, Satkhira during 2018-20

Farmer's name	Number of vine (January 2019)	Number of vines (December 2020)	Creeper types
Masudur Rahman Zadu	6	8	Wall & tree
Amir Hamza	5	6	Wall & tree
Ashik Iqbal	4	6	Tree
Shirazul Islam	3	3	Tree
Azgor Molla	4	4	Tree
Jahangir Gazi	5	7	Tree
Abdul Malek Fakir	3	5	Tree
Nuruzzaman	6	6	Tree
Mizanur Gazi	2	4	Tree
Prodip Bala	3	3	Tree
Arafat Lalu	4	4	Tree
Total	45	52	



Picture 11.8. Spices production in the shady places at FSRD Site, Kaliganj, Satkhira

11.1.11. Establishment of mini orchard in the backside of the homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)

A mini orchard of lemon (var. kagji) was developed at the homestead during 2020-21. Thirteen lemon saplings were distributed to the farmer. The survival rate is satisfactory and now in growing stage.

11.1.12. Plantation and management of existing fruits trees in homestead at the FSRD Site: Shyamnagar, Satkhira (BINA)

Saplings of different fruit trees were distributed among the farmers of FSRD Site Shyamnagar, Satkhira from 2018-2021 are presented in Table 11.23. Saplings of mango, lemon, Kodbel, malta, guava, pummelo, custard apple, sapota, litchi, dragon fruit, emblica, horitoki, bohera and coconut were distributed among the farmers of FSRD site. A total of 875 saplings of different exotic and indigenous fruit and medicinal species were distributed among the farmers of the FSRD site during 2018 to 2021. Recommended management practices were followed during plantation of the saplings. The survivability of different fruit saplings are ranges from 60-100%. The sapling is now in growing stage.

Table 11.23. Distribution of different fruit tree saplings among the cooperator farmers at FSRD Site, Shyamnagar, Satkhira during 2018 to 2021

Sl. No.	Types of the fruit saplings	Variety	No. of saplings	No. of farmers	Survivability (%)
1	Mango	BARI Aam-3, Gobindovog, Harivanga, Himsagor and Shitavog	260	30	90
2	Litchi	BARI Litchi-3	12	12	80
3	Kodbel	Local	36	18	87
4	Guava	BARI Payera-2	36	12	86
5	Black Pepper	Hybrid	24	12	60
6	Lemon	Kagji	165	25	92
7	Pummelo	Thai	20	12	81
8	Custard Apple	Local	20	15	78
9	Sapota	Local	40	12	92
10	Emblica	BARI Amloki-1	40	15	86
11	Dragon Fruit	BARI Dragon fruit -1	78	15	100

Sl. No.	Types of the fruit saplings	Variety	No. of saplings	No. of farmers	Survivability (%)
12	Coconut	Vietnami	24	12	95
13	Horitoki	Local	30	15	97
14	Bohera	Local	30	15	89
15	Malta	BARI Malta-1	60	15	84
Total			875		Range (60-100)



Picture 11.9. Fruit saplings distribution at FSRD Site Shyamnagar, Satkhira

11.1.13. Movable seedbed for winter vegetables seedlings production at FSRD Site: Subarnachar, Noakhali (BARI)

Total 35 to 40 days required for the preparation of the seedbed and selling the seedlings where farmers could earn Tk. 3180 if he started from last week of September. The economic analysis of seedbed for vegetables seedlings is given in the Table 11.24.

Table 11.24. Cost and return analysis of movable seedbed at FSRD Site, Subarnachar, Noakhali during late Kharif II season of 2019 and 2020

Sl. No.	Expenditure items	TVC (TK..)	Seedlings (No.)	GR (Tk.)	GM (Tk.)
1	30 ft long 2 pcs Bamboo (@ TK. 250 per pcs)	500/-	Cabbage-1767 pcs Cauliflower-1742 pcs Broccoli-1784 pcs Tomato-683 pcs	10727	6772
2	15 ft long 13 pcs Muli bamboo (@ TK. 30 per pcs)	390/-			
3	6.6 ft width and 10 ft long with 4"X4" mash Net (@ TK. 160 per 6.6 ftX32.8ft)	50/-			
4	6 ft width and 10 ft long with thickness 08 Mils (0.008 inches) Polythene sheet-3.5 Yard (@ TK. 45 per Yard) 6 ft width and 8 ft long Polythene with thickness 05 Mils (0.005 inches) - 3Yard (@ TK. 40 per Yard)	265/-			
5	250 g Rope (@ TK. 100 per Kg), 6 ft width and 9 ft long Jute gunny cover (@ TK. 25 per Yard)	175/-			
6	Seeds of cabbage (10 g), cauliflower (10 g), broccoli (10 g) and tomato (5 g)	1265/-			
7	Vermicompost (15 Kg @ TK. 20 per Kg), Straw (50 Kg @ TK. 2 per Kg), Coco dust (20 Kg @ TK. 10 per Kg), Fungicide (Provax 200 WP @ TK. 130 per 10 g), Bioderma (20 g @ TK. 500 per Kg) and Root hormone (15 g @ TK. 120 per Kg)	810/-			
8	Labour (1 person one day)	500/-			
Total cost		3955/-	5976 pcs		

*Price of seedling (pcs per TK.): Cauliflower and Broccoli =2 TK. per pcs; Cabbage and Tomato = TK..1.5 per pcs

*GR=Gross Return, TVC=Total Variable Cost, GM=Gross Margin



Picture 11.10. Seedling production and selling from moveable seedbed at FSRD Site, Subarnachar Noakhali

11.1.14. Family Labour utilization

It has been observed labour utilization pattern of four FSRD sites that woman had a good involvement in intercultural operations, harvesting and in cooking. It was also observed that average of four FSRD sites 95% women and 5% children are engaged in cooking (Table 11.25). Land preparation and fencing was done by male person of the household whereas seed/seedling, sowing and harvesting was also done by them. Marketing was done mainly by male and children of the household.

Table 11.25. Family labor utilization pattern for homestead production system at four FSRD Sites of coastal ecosystem

Purpose of labour use	Percent of utilization		
	Men (%)	Women (%)	Children (%)
Land preparation	75	15	10
Seed/seedling	35	55	10
Sowing/planting	35	50	15
Fencing	85	10	5
Intercultural operations	35	55	10
Harvesting	15	75	10
Marketing	75	5	20
Cooking	-	95	5



Picture 11.11. Family labour utilization patterns at FSRD Sites under coastal ecosystem

11.2. Crops and cropping system

The crops and cropping system in costal ecosystem were performed with a view to develop improved cropping pattern as well as to increase crop productivity by introducing new technology or variety. During 2018-2020, 2-3 cropping patterns were developed each site in costal ecosystem.

11.2.1. Improvement of existing cropping pattern at FSRD site: Subarnachar, Noakhali (BARI)

1. Improvement of the existing Groundnut-Fallow-T. Aman cropping pattern through inclusion of short duration T. Aus and T. Aman variety

Existing CP: Groundnut (Dhaka-1)-Fallow-T. Aman (Sharwna)

Improved CP: Groundnut (Dhaka-1) -T. Aus (Binadhan-19)-T. Aman (BRRI dhan87)

In the improved cropping pattern, average groundnut yield (1.07 t ha^{-1}) was higher than the existing cropping pattern might be due to optimum use of fertilizers and other improve management. Inclusion of modern Aus rice variety into the cropping pattern also provided more economic return compared to existing cropping pattern. BRRI dhan87 is earlier than Sharwna which help early sowing of groundnut in the improved pattern. This type of cropping pattern is suitable for the lands which located near canal or slightly higher than medium high land. Yield, cost and return analysis, it was observed that, improved cropping pattern performed better than the existing cropping pattern (Table 11.26). The average rice equivalent yield (12.48 t ha^{-1}) and gross margin (Tk.102157 /ha) were found from improved cropping pattern Groundnut (Dhaka-1) -T. Aus (Binadhan-19) -T. Aman (BRRI dhan87). The RYT (65.51%) and GM (64.19%) were higher than existing cropping pattern. The marginal benefit cost ratio (MBCR) was found 1.68 which indicated the superiority of the three crops pattern over farmers' two crops cropping pattern.

Farmer's opinioned that cultivation of Aus rice is possible within their existing cropping pattern and it will be helpful for them to increase the economic return. Moreover, they also expressed that rainfall and landowner demands are the main factor to adopting such type of cropping pattern. It is notable that some year heavy rainfall occurred during *Rabi* season and there is no or enough rainfall for planting Aus rice during *Kharif* season. Moreover, lack of irrigation during dry month is another problem for planting Aus rice.



Picture 11.12. Improved cropping pattern practiced at FSRD Site, Subarnachar, Noakhali

Table 11.26. Average yield and economic analysis of improved and existing cropping pattern at the FSRD Site, Subarnachar, Noakhali during 2018-19 and 2019-2020

Observation		Improved cropping pattern			Existing cropping pattern		
Crop	Year	Groundnut	T. Aus	T. Aman	Groundnut	Fallow	T. Aman
Seed /Grain Yield (t ha^{-1})	2018-19	1.15	4.08	4.38	1.01	-	4.15
	2019-20	0.98	3.92	4.11	0.89	-	4.02
Seed/Grain Yield (t ha^{-1})		1.07	3.72	4.25	0.95	-	4.09
Stover/ Straw yield (t ha^{-1})	2018-19	2.19	4.57	4.92	2.10	-	5.04
	2019-20	2.01	4.29	4.76	1.96	-	4.93
Stover/ Straw Yield (t ha^{-1})		2.10	4.43	4.84	2.03	-	4.99

Observation		Improved cropping pattern			Existing cropping pattern		
Crop	Year	Groundnut	T. Aus	T. Aman	Groundnut	Fallow	T. Aman
REY (t ha ⁻¹)	2018-19	3.56	4.54	4.87	3.14	-	4.65
	2019-20	3.04	4.35	4.59	2.77	-	4.51
REY (t ha ⁻¹)		3.30	4.45	4.73	2.95	-	4.58
Whole pattern Rice equivalent yield (t ha ⁻¹)	2018-19	12.97			7.79		
	2019-20	11.98			7.28		
WPREY yield (t ha ⁻¹)		12.48			7.54		
GR (Tk. ha ⁻¹)		66000	89140	94580	59030	-	91670
TVC (Tk. ha ⁻¹)		32378	52018	63167	29792	-	58690
GM (Tk. ha ⁻¹)		33622	37122	31413	29238		32980
WPGM (Tk. ha ⁻¹)		102157			62218		
MBCR		1.68					

Input and output price per Kg: Groundnut selling price = 60/-, Paddy selling price = 20/-, Straw=2/-, Stover=1/-, Urea=16/-, TSP= 22/-, MoP=15/-, Gypsum=12/-, Zinc Sulphate= 120/-, Labour = 500/- per day

*Av. = Average, REY= Rice Equivalent Yield, WPREY= Whole Pattern Rice Equivalent Yield. GR= Gross Return, TVC=Total Variable Cost, GM= Gross Margin, WPGM=Whole Pattern Gross Margin, MBCR=Marginal Benefit Cost Ratio

11.2.2 Improvement of the existing Soybean-Fallow-T. Aman cropping pattern through inclusion of modern soybean varieties and Aus rice

Existing CP: Soybean (Shohag)-Fallow-T. Aman (Sharwna/BRRI dhan52)

Improved CP: Soybean (BARI Soybean-6)-T. Aus (BRRI dhan85)-T. Aman (BRRI dhan52)

Under the improved cropping pattern, the modern variety of soybean was introduced by replacing the low yielding Shohag variety (Khan, *et al.*, 2013). The average yield of Shohag is 1.5 to 1.8 t ha⁻¹. In course of time, BARI developed two high yielding varieties namely BARI Soybean-5 (in 2002) and BARI Soybean-6 (in 2009). The yield of new variety was about 10 to 15% higher than the yield of Shohag variety. The result of the cropping pattern trials indicated that the yield of T. Aman in improved practice was slightly higher than of conventional pattern. This may be due to better management practice in improved pattern as well as suitability of the particular variety according to the land and soil types. In improved pattern, T. Aus (BRRI dhan85) produced grain yield of 3.93 t ha⁻¹ and BARI Soybean-6 produced 31% more yield over existing Shohag variety. Moreover, replacing of soybean variety in *Rabi* season and inclusion of T. Aus in *Kharif* season in the existing cropping pattern increased rice equivalent yield (REY) by 73% compared to farmers' existing cropping pattern. From the economic point of view, the improved cropping pattern showed its superiority over farmers' pattern during both the trial periods. In improved pattern, the whole pattern gross margin was Tk.105688 ha⁻¹ which was more than 63% higher over farmers' existing pattern (Table 11.27). The higher gross margin of the improved pattern was achieved mainly higher yield, inclusion of additional crop and high yielding new soybean variety.

Table 11.27. Average yield and economic analysis of improved and existing cropping pattern at the FSRD Site, Subarnachar, Noakhali during 2018-19 and 2019-2020

Observation		Improved cropping pattern			Existing cropping pattern		
Crop	Year	Soybean	T. Aus	T. Aman	Soybean	Fallow	T. Aman
Seed /Grain Yield (t ha ⁻¹)	2018-19	2.16	3.91	4.19	1.63	-	4.13
	2019-20	2.05	3.95	4.09	1.58	-	4.06

Observation		Improved cropping pattern			Existing cropping pattern		
Crop	Year	Soybean	T. Aus	T. Aman	Soybean	Fallow	T. Aman
Seed/Grain Yield (t ha ⁻¹)		2.11	3.93	4.14	1.61	-	4.10
Stover/ Straw yield (t ha ⁻¹)	2018-19	2.59	4.61	5.01	2.17	-	4.94
	2019-20	2.45	4.74	4.92	2.06	-	4.99
Stover/ Straw Yield (t ha ⁻¹)		2.52	4.68	4.97	2.12	-	4.97
Rice equivalent yield (t ha ⁻¹)	2018-19	3.37	4.37	4.69	2.55	-	4.62
	2019-20	3.20	4.19	4.58	2.47	-	4.56
REY (t ha ⁻¹)		3.29	4.28	4.64	2.51	-	4.59
Whole pattern Rice equivalent yield (t ha ⁻¹)	2018-19	12.43			7.17		
	2019-20	11.97			7.03		
WPREY yield (t ha ⁻¹)		12.20			7.10		
GR (Tk ha ⁻¹)		65670	87950	92730	50265	-	91830
TVC (Tk ha ⁻¹)		24275	53220	63167	18740	-	58690
GM (Tk ha ⁻¹)		41395	34730	29563	31525		33140
WPGM (Tk ha ⁻¹)		105688			64665		
MBCR					1.65		

Input and output price per Kg: Soybean selling price = 30/-, Paddy selling price = 20/-, Straw=2/-, Stover=1/-, Urea=16/-, TSP= 22/-, MoP=15/-, Gypsum=12/-, Zinc Sulphate= 120/-, Labour = 500/- per day

*Av. = Average, REY= Rice Equivalent Yield, WPREY= Whole Pattern Rice Equivalent Yield. GR= Gross Return, TVC=Total Variable Cost, GM= Gross Margin, WPGM=Whole Pattern Gross Margin, MBCR=Marginal Benefit Cost Ratio



Picture 11.13 Improved cropping pattern practiced at FSRD Site, Subarnachar, Noakhali

1.2.3. Improvement of the existing Fallow- Fallow - T. Aman (BR23) cropping pattern through inclusion of underutilized cereal crop and green manuring crop.

Existing CP: Fallow - Fallow - T. Aman (Sharna)

Improved CP: Proso millet (BARI Cheena-1) - Green manure - T. Aman (BR23)

In improved cropping pattern, by incorporation of Proso millet as salinity escape crops an extra 1.57 t ha⁻¹ yield was obtained. On the other hand, at the same time the land remains fallow due to high salinity progression during mid February to March in the existing cropping pattern. Moreover, inclusion of green manuring crop reduced the amount of nitrogen fertilizer for succeeding crop and soil salinity assumes to decrease in the next year due to land coverage during *Kharif I* season (Sharma and Prasad, 1999). Inclusion of Proso millet in *Rabi* season in alternate cropping pattern (7.42 t ha⁻¹yr⁻¹) increased REY about 69% compared to farmers practiced (Table 11.28). From the economic point of view, Proso Millet-Fallow-T. Aman cropping pattern provided Tk. 64000 ha⁻¹ as whole pattern gross margin which was 118% higher than the existing cropping pattern. In addition, the marginal benefit cost ratio was 2.31 obtained from improve

Table 11.28. Performance of improved and existing cropping pattern at FSRD Site, Subarnachar, Noakhali

Observation		Improved cropping pattern			Existing cropping pattern		
Crop	Year	Proso millet	Green manure	T. Aman	Fallow	Fallow	T. Aman
Grain Yield (t ha ⁻¹)	2018-19	1.65	-	4.04	-	-	3.92
	2019-20	1.49	-	4.12	-	-	3.87
Seed/Grain Yield (t ha ⁻¹)		1.57	-	4.08	-	-	3.90
Straw yield (t ha ⁻¹)	2018-19	1.93	-	4.86	-	-	5.10
	2019-20	1.81	-	4.95	-	-	4.97
Stover/ Straw Yield (t ha ⁻¹)		1.87	-	4.91	-	-	5.04
Rice equivalent yield (t ha ⁻¹)	2018-19	2.98	-	4.53	-	-	4.43
	2019-20	2.70	-	4.62	-	-	4.37
REY (t ha ⁻¹)		2.84	-	4.58	-	-	4.40
Whole pattern Rice equivalent yield (t ha ⁻¹)	2018-19	7.51			4.43		
	2019-20	7.32			4.37		
WPREY yield (t ha ⁻¹)		7.42			4.40		
GR (Tk ha ⁻¹)		56820	-	90520	-	-	87970
TVC (Tk ha ⁻¹)		18650	5700	59890	-	-	58570
GM (Tk ha ⁻¹)		38170	-	30630			29400
WPGM (Tk ha ⁻¹)		64000			29400		
MBCR		2.31					

Input & output price per Kg: Proso millet selling price = 35/-, Paddy selling price = 20/-, Rice Straw=2/-, Millet Straw=1/-, Urea=16/-, TSP= 22/-, MoP=15/-, Gypsum=12/-, Labour = 500/- per day *Av. = Average, REY= Rice Equivalent Yield, WPREY= Whole Pattern Rice Equivalent Yield. GR= Gross Return, TVC=Total Variable Cost, GM= Gross Margin, WPGM=Whole Pattern Gross Margin, MBCR=Marginal Benefit Cost Ratio



Picture 11.14 Improved cropping pattern practiced at FSRD site, Subarnachar, Noakhali

11.2.4. Development of Potato-Mungbean-T. Aman cropping pattern against Mungbean-Fallow-T. Aman cropping pattern at FSRD Site: Jamla, Patuakhali (BARI)

Existing Cropping Pattern: Mungbean (BARI Mung-6) - Fallow - T. Aman (Moulata)

Improved CP: Potato (BARI Alu-72) - Mungbean (BARI Mung-6) - T. Aman (BRRI dhan49)

In developed pattern, incorporation of potato before mungbean gave an extra yield of 21.6 tha⁻¹ (Nazrul *et al.*, 2013). During the *kharif* I season the land was occupied by mungbean whereas in existing pattern the land was remaining fallow during *Rabi* season (Table 11.29). In T. Aman about 47% yield increased due to incorporation of modern variety along with balance fertilizer, appropriate seedling rate and age and other management practices. The improved cropping gave the higher REY 18.97 t ha⁻¹ year⁻¹, total gross margin Tk. 218578 ha⁻¹ and MBCR 2.81 (Table 11.29).

Table 11.29. Performance of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali during 2018-19 and 2019-2020

Observation		Improved cropping pattern			Existing cropping pattern		
Crop	Year	Potato	Mungbean	T. Aman	Mungbean	Fallow	T. Aman
Grain Yield (t ha ⁻¹)	2018-19	19.86	1.3	4.35	1.56	-	3.26
	2019-20	21.6	1.2	4.46	1.48	-	3.05
Seed/Grain Yield (t ha ⁻¹)		20.73	1.25	4.41	1.52	-	3.16
Straw yield (t ha ⁻¹)	2018-19	-	-	3.98	-	-	4.02
	2019-20	-	-	4.10	-	-	3.98
Straw Yield (t ha ⁻¹)		-	-	4.04	-	-	4.00
Rice equivalent yield (t ha ⁻¹)	2018-19	9.93	3.58	4.75	4.29	-	3.66
	2019-20	10.80	3.30	4.87	4.07	-	3.45
REY (t ha ⁻¹)		10.37	3.44	4.81	4.18	-	3.56
Whole pattern Rice equivalent yield (t ha ⁻¹)	2018-19	18.26			7.95		
	2019-20	18.97			7.52		
WPREY yield (t ha ⁻¹)		18.62			7.74		
GR (Tk ha ⁻¹)		207400	68750	92140	83600	-	67100
TVC (Tk ha ⁻¹)		73472	30600	45640	30600	-	41950
GM (Tk ha ⁻¹)		133928	38150	45640	53000		25150
WPGM (Tk ha ⁻¹)		218578			78150		
MBCR		2.81					

Input & output price per Kg: Potato selling price = 10/-, Mungbean selling price = 55/-, Paddy selling price = 20/-, Rice Straw=2/-, Urea=16/-, TSP= 22/-, MoP=15/-, Gypsum=12/-, Labour = 500/- per day *Av. = Average, REY= Rice Equivalent Yield, WPREY= Whole Pattern Rice Equivalent Yield. GR= Gross Return, TVC=Total Variable Cost, GM= Gross Margin, WPGM=Whole Pattern Gross Margin, MBCR=Marginal Benefit Cost Ratio



Picture 11.15. Improved cropping pattern practiced at FSRD Site, Jamla, Patuakhali

11.2.5. Development of Sunflower-T. Aus-T. Aman cropping pattern against Grasspea - Fallow-T. Aman cropping pattern at FSRD Site: Jamla, Patuakhali (BARI)

Existing CP: Grasspea (Local)-Fallow - T. Aman (Moulata)

Developed CP: Sunflower (BARI Surjomukhi-2)- T. Aus (BRRI dhan48)-T. Aman (BRRI dhan52)

Agronomic and economic performance of the tested pattern against existing pattern is presented in Table 11.30. In the developed pattern, grasspea has been replaced by sunflower and incorporated Aus rice in the existing pattern. It was observed that the Rice Equivalent Yield increased about 139% as grasspea replaced by sunflower increased gross return Tk. 57500 and Aus rice incorporation added extra gross return of Tk. 80400. Gross margin increased Tk. 85770 over existing pattern that contributed to make more marginal benefit over marginal cost (Table 11.30).

Table 11.30. Performance of improved and existing cropping pattern at FSRD Site, Jamla, Dumki, Patuakhali during 2018-19 and 2019-2020

Observation		Developed cropping pattern			Existing cropping pattern		
Crop	Year	Sunflower	T. Aus	T. Aman	Grasspea	Fallow	T. Aman
Grain Yield (t ha ⁻¹)	2018-19	1.78	4.12	4.69	0.64	-	3.41
	2019-20	1.84	3.92	4.58	0.85	-	3.45
Seed/Grain Yield (t ha ⁻¹)		1.81	4.02	4.64	0.75	-	3.43
Straw yield (t ha ⁻¹)	2018-19	-	4.62	3.75	1.2	-	3.88
	2019-20	-	4.39	3.89	1.72	-	4.35
Stover/Straw Yield (t ha ⁻¹)		-	4.51	3.82	1.46	-	4.12

Observation		Developed cropping pattern			Existing cropping pattern		
Crop	Year	Sunflower	T. Aus	T. Aman	Grasspea	Fallow	T. Aman
Rice equivalent yield (t ha ⁻¹)	2018-19	4.45	4.58	5.07	1.72	-	3.80
	2019-20	4.60	4.36	4.97	2.30	-	3.89
REY (t ha ⁻¹)		4.53	4.47	5.02	2.01	-	3.85
Whole pattern Rice equivalent yield (t ha ⁻¹)	2018-19	14.10			5.52		
	2019-20	13.93			6.19		
WPREY yield (t ha ⁻¹)		14.02			5.86		
Gross Return (Tk ha ⁻¹)		90500	80400	96620	33000	-	72715
Total Variable Cost (Tk ha ⁻¹)		53600	41180	41680	17400	-	43025
Gross Margin (Tk ha ⁻¹)		36900	39220	54940	15600	-	29690
WPGM (Tk ha ⁻¹)		131060			45290		
MBCR		2.13					

Input and output price per Kg: Sunflower selling price = 50/-, Grass pea-selling price = 50/-, Paddy selling price = 20/-, Urea=16/-, TSP= 22/-MoP=15/-, Gypsum=12/-, Zinc Sulphate= 110/-, Labour = 500/- per day. *Av. = Average, REY= Rice Equivalent Yield, WPREY= Whole Pattern Rice Equivalent Yield. GR= Gross Return, TVC=Total Variable Cost, GM= Gross Margin, WPGM=Whole Pattern Gross Margin, MBCR=Marginal Benefit Cost Ratio

11.2.6. Improvement of existing Boro-Fallow-T. Aman cropping pattern at FSRD Site: Kaliganj, Satkhira (BRRI)

The improved cropping pattern Mustard (BARI Sarisha-14)-Boro (BRRI dhan81)-T. Aman (BRRI dhan75) were tested against existing cropping pattern Boro (BRRI dhan28)-Fallow-T. Aman (BRRI dhan49) during 2018-2019. The REY of existing Boro (BRRI dhan28)-Fallow-T. Aman (BRRI dhan49) cropping pattern was 11.76 t ha⁻¹ Year⁻¹. The gross margin of this pattern was Tk. 114640 ha⁻¹ with the BCR of 1.95. The REY of improved cropping pattern, Mustard (BARI Sarisha-14)-Boro (BRRI dhan81)-T. Aman (BRRI dhan75) was 16.26 t ha⁻¹ year⁻¹ with the gross margin of Tk. 170750 ha⁻¹ and MBCR of 2.66 during 2018-19 (Table 11.31).

Table 11.31. Yield and economic analysis of alternate and existing cropping pattern at the FSRD site, Kaliganj, Satkhira during 2018-2019

Observation	Improved pattern			Existing pattern	
	Mustard	Boro	T. Aman	Boro	T. Aman
Seed /grain Yield (t ha ⁻¹)	1.09	6.29	5.88	5.87	4.55
Straw yield (t ha ⁻¹)	1.20	4.90	4.15	4.80	4.1
Rice equivalent yield (t ha ⁻¹)	2.73	7.03	6.50	6.59	5.17
Whole pattern Rice equivalent yield (t ha ⁻¹)	16.26			11.76	
Gross return (Tk. ha ⁻¹)	54600	140600	130000	131800	103400
Total variable cost (Tk. ha ⁻¹)	26800	68950	58700	65760	54800
Gross margin (Tk. ha ⁻¹)	27800	71650	71300	66040	48600
Whole pattern Gross margin (Tk. ha ⁻¹)	170750			114640	
MBCR	2.66			-	

Unit price (Tk. kg⁻¹): Rice=20.00, Rice straw =3, Mustard=50.00, Mustard straw has no market value

Two improved cropping pattern of Mustard (BARI Sarisha-14)-Boro (BRRI dhan81)-T. Aman (BRRI dhan75) and Boro (BRRI dhan81)-Jute (NSC)-T. Aman (BRRI dhan75) were tested against existing cropping Boro- Fallow – T. Aman during 2019-20. The REY of these two cropping patterns were 16.76 t ha⁻¹ Year⁻¹ and 20.75 t ha⁻¹ Year⁻¹ with the gross margin of Tk. 178100 ha⁻¹ and Tk. 210000 ha⁻¹ following the MBCR of 2.72 and 2.11, respectively. On the other hand, the REY and gross margin of the existing cropping pattern were found 11.98 t ha⁻¹ Year⁻¹ and Tk. 117620 ha⁻¹, respectively (Table 11.32).

The short growth duration of T. Aman rice variety BRRI dhan75 is made an opportunity for another extra crop in between Boro and T. Aman rice. BARI Sarisha-14, a short duration variety and Jute fitted well to

increase the production as well. The farmers are happy with the production of short duration newly introduced BRRi dhan75 with its grain quality in T. Aman season as well as BRRi dhan81 in Boro season. An additional crop mustard or jute can easily introduce in between the two rice for getting higher profit margin (Khan *et al.*, 2013; Chowdhury *et al.*, 2017), The field duration of these two improved cropping patterns were 272-300 days only.

Table 11.32. Yield and cost return analysis of alternate cropping pattern at the FSRD Site, Kaliganj, Satkhira during 2019-20

Observation	Improved pattern-1			Improved pattern-2			Existing pattern	
	Mustard	Boro	T. Aman	Boro	Jute	T. Aman	Boro	T. Aman
Seed /grain Yield (t ha ⁻¹)	1.28	6.48	5.66	6.35	3.39	5.15	5.95	4.68
Straw yield (t ha ⁻¹)	1.22	5.10	4.30	5.00	2.48	4.28	4.80	4.2
Rice equivalent yield (t ha ⁻¹)	3.20	7.25	6.31	7.10	7.86	5.79	6.67	5.31
Whole pattern Rice equivalent yield (t ha ⁻¹)	16.76			20.75			11.98	
Gross return (Tk. ha ⁻¹)	64000	145000	126200	142000	157200	115800	133400	106200
Total variable cost (Tk. ha ⁻¹)	27700	70550	58850	68300	78200	58500	66780	55200
Gross margin (Tk. ha ⁻¹)	36300	74450	67350	73700	79000	57300	66620	51000
Whole pattern Gross margin (Tk. ha ⁻¹)	178100			210000			117620	
MBCR	2.72			2.11			-	

Unit price (Tk. kg⁻¹): Rice=20.00, Rice straw =3, Mustard=50.00, Mustard straw has no market value in the area, Jute=42, Jute straw=6



Picture 11.16. Improved cropping pattern practiced at FSRD Site, Kaliganj, Satkhira

11.2.7. Improvement of existing Vegetables-Rice cropping pattern at FSRD Site: Kaliganj, Satkhira (BRRi)

The REY of existing Khira-Fallow-T. Aman (BRRi dhan49) cropping pattern was 13.19 t ha⁻¹ Year⁻¹ while the gross margin of the pattern was Tk. 122150 ha⁻¹ with BCR of 1.86. After intervention during 2018-19, improved cropping pattern of Khira + Turnip-T. Aman (BRRi dhan75) and Broccoli + Pumpkin-T. Aman (BRRi dhan75) were introduced. The REY of these two cropping patterns were 28.28 t ha⁻¹ year⁻¹ and 27.08 t ha⁻¹ year⁻¹, respectively. Gross margin was Tk. 264200 ha⁻¹ and Tk. 260150 ha⁻¹ with the MBCR 1.89 and 1.99, respectively (Table 11.33).

Table 11.33. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2018-19

Observation	Improved pattern-1			Improved pattern-2			Existing pattern	
	Khira	+ Turnip	T. Aman	Broccoli	+ Pumpkin	T. Aman	Khira	T. Aman
Seed /grain Yield (t ha ⁻¹)	12.82	17.0	5.29	9.22	19.0	5.29	10.46	4.72
Straw yield (t ha ⁻¹)	-	-	4.1	-	-	4.1	-	4.1
Rice equivalent yield (t ha ⁻¹)	9.62	12.75	5.91	6.92	14.25	5.91	7.85	5.34
Whole pattern Rice equivalent yield (t ha ⁻¹)	28.28			27.08			13.19	
Gross return (Tk. ha ⁻¹)	255000	192300	118200	138300	285000	118200	156900	106800
Total variable cost (Tk. ha ⁻¹)	136550	105250	59500	74550	147300	59500	86750	54800
Gross margin (Tk. ha ⁻¹)	118450	87050	58700	63750	137700	58700	70150	52000
Whole pattern Gross margin (Tk. ha ⁻¹)	264200			260150			122150	
MBCR	1.89			1.99			-	

Unit price (Tk. kg⁻¹): Rice=20.00, Rice straw =3, Vegetables=15.00

The REY of the existing cropping pattern of Khira-Fallow-T. Aman (BRRI dhan49) was 13.52 t ha⁻¹ year⁻¹ with the gross margin of Tk. 125700 ha⁻¹. After intervention during 2019-20, the REY of Khira + Turnip-T. Aus (BRRI dhan85)-T. Aman (BRRI dhan75) cropping pattern was 28.43 t ha⁻¹ year⁻¹ with gross margin of Tk. 286350 ha⁻¹ and MBCR of 2.17 (Table 11.34). Short duration rice variety in T. Aman season allow to produce two vegetables in relay cropping with Aus rice also. These improved cropping patterns were increased the REY from the same area. Tested three cropping patterns ensured to increase the crop diversity and total productivity as well as the farm income. Farmers' preferred BRRI dhan75 as its higher grain quality, shorter growth duration with higher yield. The field duration of the tested four cropped cropping pattern was <300 days, can easily practice in the field level. Better quality seeds, higher cropping intensity along with proper management and fertilizer dose helped to improve the whole pattern REY of the improved cropping patterns.

Table 11.34. Yield and economic analysis of alternate cropping pattern at FSRD site, Kaliganj, Satkhira during 2019-20

Observation	Improved cropping pattern				Existing pattern	
	Khira	+ Turnip	T. Aus	T. Aman	Khira	T. Aman
Seed /grain yield (t ha ⁻¹)	13.82	9.17	4.58	5.38	10.68	4.88
Straw yield (t ha ⁻¹)	-	-	3.8	4.3	-	4.2
Rice equivalent yield (t ha ⁻¹)	10.37	6.88	5.15	6.03	8.01	5.51
Whole pattern Rice equivalent yield (t ha ⁻¹)	28.43				13.52	
Gross return (Tk. ha ⁻¹)	207300	137550	103000	120600	160200	110200
Total variable cost (Tk. ha ⁻¹)	96300	72500	53400	59900	89500	55200
Gross margin (Tk. ha ⁻¹)	111000	65050	49600	60700	70700	55000
Whole pattern Gross margin (Tk. ha ⁻¹)	286350				125700	
MBCR	2.17				-	

Unit price (Tk. kg⁻¹): Rice=20.00, Rice straw =3, Vegetables=15.00



Picture 11.17. Improved cropping pattern practiced at FSRD Site, Kaliganj, Satkhira

11.2.8. Development of alternate cropping pattern at FSRD Site: Kaliganj, Satkhira (BRR)

Three alternate cropping patterns were tested against existing cropping pattern Boro (BRR dhan28) -Fallow-T. Aman (BRR dhan49) during 2018-19 at FSRD Site, Kaliganj, Satkhira

ACP1: Khira + Pumpkin-Jute-T. Aman (BRR dhan75)

ACP2: Mustard-Mungbean-Jute –T. Aman (BRR dhan75)

ACP3: Cabbage + Spinach-Boro (BRR dhan81)-T. Aman (BRR dhan75)

The REY of existing Boro (BRR dhan28)-Fallow-T. Aman (BRR dhan49) cropping pattern was 11.76 t ha⁻¹ Year⁻¹ with gross margin of Tk. 114640 ha⁻¹. The REY of the ACP1, ACP2 and ACP3 were 35.87 t ha⁻¹, 19.32 t ha⁻¹ year⁻¹ and 29.05 t ha⁻¹ year⁻¹, respectively. Whole pattern gross margins of ACP1, ACP2 and ACP3 were Tk. 372400 ha⁻¹, Tk. 192700 ha⁻¹ and Tk. 289000 ha⁻¹ with the MBCR of ACP1, ACP2 and ACP3 were 2.15, 2.07 and 2.02, respectively. The REY and gross margin of three alternate cropping patterns were higher than existing pattern (Table 11.35).



Picture 11.18. Developed cropping pattern practiced at FSRD Site, Kaliganj, Satkhira

Table 11.35. Yield and economic analysis of alternate and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2018-19

Observation	Improved cropping pattern-1				Improved cropping pattern-2			
	Khira + Pumpkin	Jute	T. Aman		Mustard	Mung bean	Jute	T. Aman
Seed /grain Yield (t ha ⁻¹)	10.34	18.5	3.43	5.01	1.0	1.4	3.15	5.67
Straw yield (t ha ⁻¹)	-	-	2.64	4.1	1.15	-	2.47	4.3
Rice equivalent yield (t ha ⁻¹)	7.76	13.88	8	6.24	2.50	3.15	7.36	6.32
Whole pattern Rice equivalent yield (t ha ⁻¹)	35.87				19.32			

Observation	Improved cropping pattern-1				Improved cropping pattern-2			
Crop	Khira + Pumpkin	Jute	T. Aman	Mustard	Mung bean	Jute	T. Aman	
Gross return (Tk. ha ⁻¹)	155100	277500	159900	124800	50000	63000	147120	126300
Total variable cost (Tk. ha ⁻¹)	73900	129500	81200	60300	26200	27400	80320	59800
Gross margin (Tk. ha ⁻¹)	81200	148000	78700	64500	23800	35600	66800	66500
Whole pattern Gross margin (Tk. ha ⁻¹)	372400				192700			
MBCR	2.15				2.07			
Observation	Improved cropping pattern-3				Existing cropping pattern			
Crop	Cabbage + Spinach	Boro	T. Aman	Boro	Fallow	T. Aman		
Seed /grain Yield (t ha ⁻¹)	16.8	4.48	6.26	5.49	5.87		4.55	
Straw yield (t ha ⁻¹)	-	-	4.7	4.2	4.80		4.10	
Rice equivalent yield (t ha ⁻¹)	12.6	3.36	6.965	6.12	6.59		5.17	
Whole pattern Rice equivalent yield (t ha ⁻¹)	29.05				11.76			
Gross return (Tk ha ⁻¹)	252000	67200	139300	122400	131800		103400	
Total variable cost (Tk ha ⁻¹)	128300	34000	69300	60300	65760		54800	
Gross margin (Tk ha ⁻¹)	123700	33200	70000	62100	66040		48600	
Whole pattern Gross margin (Tk. ha ⁻¹)	289000				114640			
MBCR	2.02				-			

Unit price (Tk. kg⁻¹): Rice=20.00, Rice straw =3, Mustard=50.00, Mustard straw has no market value, Jute=42.00, Jute straw=6, Vegetables=15, Mung bean=45.00

For more conformation based on previous year result and experienced the following two alternat cropping patterns were tested against existing Boro (BRRI dhan28) -Fallow-T. Aman (BRRI dhan49) cropping pattern during 2019-20.

ACP1: Mustard- Mungbean -Jute -BRRI dhan75

ACP2: Cabbage +Spinach-BRRI dhan81-BRRI dhan75

The REY of ACP1 and ACP2 patterns were 20.77 t ha⁻¹ year⁻¹ and 30.86 t ha⁻¹ year⁻¹, respectively. Gross margins of whole pattern were Tk. 213490 ha⁻¹ and Tk. 309300 t/ha with the MBCR of 2.24 and 2.05, along with gross return of Tk. 415410 ha⁻¹ and Tk. 617200 ha⁻¹, respectively (Table 11.36). Whereas lower rice equivalent yield (11.81 t ha⁻¹ year⁻¹) and gross margin (Tk. 114400 ha⁻¹) were obtained from existing pattern Boro (BRRI dhan28)-Fallow-T. Aman (BRRI dhan49). Diversified crop production in different cropping patterns increased the yield and income of the farm family. Increased cropping intensity improved yield as well as produced higher gross margin. Prior to intervention, farmers used to follow Boro-Fallow-T. Aman cropping pattern which reduced the potential yield. Two vegetables with two rice based cropping pattern of Cabbage + Spinach-BRRI dhan81-BRRI dhan75 showed better yield performance and higher return as well tested during two consecutive years. Total field duration of tested pattern was less than 300 days, makes an extended turnaround time to cultivate the succeeding crop smoothly. Khira + Pumpkin-Jute- BRRI dhan75 cropping pattern produced the highest REY among the tested patterns with 333 days field duration. This pattern also makes sufficient space for the succeeding crop cultivation. After intervention, farmers are now accustomed to use better quality seeds and better management practices which subsequently increased the gross margins and MBCR also.

Table 11.36. Yield and economic analysis of alternate cropping pattern at FSRD site, Kaliganj, Satkhira during 2019-20

Observation	Improved cropping pattern-1				Improved cropping pattern-2			Existing pattern		
	Mustard	Mung bean	Jute	T. Aman	Cabbage + Spinach	Boro	T. Aman	Boro	T. Aman	
Crop										
Seed /grain Yield (t ha ⁻¹)	1.4	1.4	3.24	5.86	18.6	4.9	6.55	5.29	5.95	4.51
Straw yield (t ha ⁻¹)	1.25	-	2.68	4.35	-	-	5.1	4.2	4.8	4.2
Rice equivalent yield (t ha ⁻¹)	3.5	3.15	7.61	6.51	13.95	3.68	7.32	5.92	6.67	5.14
Whole pattern Rice equivalent yield (t ha ⁻¹)	20.77				30.86			11.81		
Gross return (Tk. ha ⁻¹)	70000	63000	152160	130250	219000	133500	146300	118400	133400	102800
Total variable cost (Tk. ha ⁻¹)	29200	28500	82320	61900	125300	54300	69300	59000	66400	55400
Gross margin (Tk. ha ⁻¹)	40800	34500	69840	68350	93700	79200	77000	59400	67000	47400
Whole pattern Gross margin (Tk. ha ⁻¹)	213490				309300			114400		
MBCR	2.24				2.05			-		

Unit price (Tk. kg⁻¹): Rice=20, Rice straw =3, Mustard=50, Mustard straw has no market value in the area, Jute=42, Jute stick=6, Vegetables=15, Mung bean=45

11.2.9. Improvement of cropping pattern at FSRD Site: Shyamnagar, Satkhira (BINA)

Cropping pattern-1

Existing CP: T. Aman (Jamaibabu/BR10) – Fallow - Boro (Binadhan-10)

Improved CP: T. Aman (Jamaibabu/BR10) – Mustard (Binasarisha-9) - Boro (Binadhan-10)

During 2018-19 average grain yield in improved cropping pattern, of Mustard (Binasharisa-9), Boro (Binadhan-10) and T. Aman (Binadhan-17) were cultivated and yield were recorded as 1.5, 6.1 and 5.7 t ha⁻¹, respectively where the existing cropping pattern produced 6.0 and 5.01 t ha⁻¹ yield of Boro (Binadhan-10) and T. Aman (Binadhan-17), respectively (Table 11.37). In 2019-2020, average grain yield in improved cropping pattern were recorded as 1.62, 5.97 and 5.67 ha⁻¹ of Mustard, Boro and T. Aman, respectively and 5.95 t ha⁻¹ and 5.12 t ha⁻¹ yield of Boro and T. Aman were recorded in the existing cropping pattern. The REY of improved and existing patterns were 16.71 t ha⁻¹ year⁻¹ and 12.1 t ha⁻¹ year⁻¹, respectively. In economic analysis, it was observed that, in both the years improved cropping pattern performed better than the existing cropping pattern. In 2018-19, the whole pattern gross margin was higher in improved cropping pattern (Tk.144182 ha⁻¹) compared to the existing cropping pattern (Tk. 94297 ha⁻¹). It was mainly due to inclusion of mustard in the pattern. In 2019-20 improved cropping pattern gave the higher gross margin (Tk. 147788 ha⁻¹) over the existing cropping pattern Tk. 93803 ha⁻¹. The marginal benefit cost ratio (MBCR) was found 1.9 and 1.92, respectively in 2018-19 and 2019-20 which indicated the superiority of the three crops pattern over farmers' pattern (Khan *et al.*, 2013). Farmer's opined that cultivation of three crops in a year increased crop productivity undoubtedly.

Table 11.37 Yield and economic analysis of alternate and existing cropping pattern at FSRD site Shyamnagar, Satkhira during 2018-2020

Observation	Improved cropping pattern			Existing cropping pattern		
	T. Aman	Mustard	Boro	T. Aman	Fallow	Boro
Year-1: 2018-19						
Seed /grain Yield (t ha ⁻¹)	5.7	1.5	6.1	5.01	-	6.0

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Mustard	Boro	T. Aman	Fallow	Boro
Straw yield (t ha ⁻¹)	4.3	3.2	4.9	4.0		4.87
Rice equivalent yield (t ha ⁻¹)						
Whole pattern Rice equivalent yield(t ha ⁻¹)	16.71			12.1		
Gross return (Tk. ha ⁻¹)	111200	73900	119600	99800	-	117740
Total variable cost (Tk. ha ⁻¹)	48980	36320	75218	49765		73478
Gross margin (Tk. ha ⁻¹)	62220	37580	44382	50035		44262
Whole pattern gross margin (Tk. ha ⁻¹)	144182			94297		
MBCR	1.9			-		
Year-2: 2019-20						
Observation	Improved cropping pattern			Existing cropping pattern		
Crop	T. Aman	Mustard	Boro	T. Aman	Fallow	Boro
Seed /grain Yield (t ha ⁻¹)	5.67	1.62	5.97	5.12	-	5.95
Straw yield (t ha ⁻¹)	4.21	3.3	4.71	4.0		4.76
Rice equivalent yield (t ha ⁻¹)						
Whole pattern Rice equivalent yield(t ha ⁻¹)	17.05			12.04		
Gross return (Tk. ha ⁻¹)	110480	79500	116880	100160		116620
Total variable cost (Tk. ha ⁻¹)	46652	37100	75320	47865		75112
Gross margin (Tk. ha ⁻¹)	63828	42400	41560	52295		41508
Whole pattern gross margin (Tk. ha ⁻¹)	147788			93803		
MBCR	1.93			-		
Average of two years						
REY	16.88			9.07		
Gross Margin (Whole pattern)	145985			94050		
MBCR	1.92			-		

Unit price (Tk. kg⁻¹): Rice= 18, straw=2 and Mustard=45

11. 2.10. Intercropping system at FSRD Site: Subarnachar, Noakhali (BARI)

Intercropping Cowpea with Garlic: The highest total productivity in terms of rice equivalent yield (7.33 t ha⁻¹) was recorded with 3:1 row ratio of garlic+cowpea intercropping pattern and lowest (5.57 t ha⁻¹) observed with 1:1 row ratio (Table 11.38). The difference in REY was mainly as a consequence of differences in the yield of garlic due to different plant population in the treatment combinations, additional component crop yield and price of individual component crop. It was observed that the all intercropping treatments were greater than one (LER > 1). This confirmed the advantage of these type of intercropping to get more production from the same area of land as compared with the same unit of area in whre sole crop

is produced. Intercropping of garlic and cowpea at 3:1 row ratio was more productive than growing them separately. The maximum gross margin (Tk. 91463 ha⁻¹) was found in garlic and cowpea at 3:1 row ratio intercropping system. Monocrop of cowpea showed the lowest gross return (Tk. 44450 ha⁻¹) as well as gross margin (Tk. 27697 ha⁻¹).

Table 11.38. Yield, rice equivalent yield (REY), LER and economic analysis of Garlic-Cowpea intercropping system at FSRD Site, Noakhali during Rabi season of 2018-19

Treatments	Yield (t ha ⁻¹)		REY (t ha ⁻¹)	LER	GR (Tk. ha ⁻¹)	TVC (Tk. ha ⁻¹)	GM (Tk. ha ⁻¹)
	Garlic	Cowpea					
Sole Garlic	4.02	-	7.04	1.00	140700	63790	76910
Sole Cowpea	-	0.89	2.23	1.00	44450	16753	27697
Garlic+ Cowpea (1:1)	2.51	0.47	5.57	1.14	111300	49373	61927
Garlic + Cowpea (2 :1)	3.27	0.37	6.55	1.22	132650	51695	80955
Garlic + Cowpea (3:1)	3.77	0.29	7.33	1.25	146300	54837	91463
Garlic + Cowpea (4:1)	3.91	0.17	7.27	1.16	145250	56985	88265

Price (TK.Kg⁻¹): Garlic = 35, Cowpea = 50, Paddy=20

*GR=Gross Return, TVC=Total Variable Cost, GM=Gross Margin

Relay Intercropping Cowpea with Sweet Potato: The highest total productivity in terms of rice equivalent yield (REY) was recorded with 4:1 row ratio of sweet potato + cowpea intercropping pattern (9.36 t ha⁻¹) and lowest observed with 1:1 row ratio (5.67 t ha⁻¹). The difference in REY was mainly as a consequence of differences in the yield of sweet potato due to competition between the component crops in the different treatment combination, component crop yield and price of individual component crop. In terms of LER, intercropping of Sweet potato and cowpea at 4:1 row ratio was more productive (1.25) than growing them separately. In the present study, only one intercrop combination showed higher monetary return than mono crops (Table 11.39). The maximum gross margin (Tk.134672 ha⁻¹) was found four row Sweet potatoes with 1 row cowpea intercropping system. Monocrop of cowpea showed the lowest gross margin (Tk.30413 ha⁻¹).

Table 11.39. Yield, rice equivalent yield (REY), LER and economic analysis of Sweet Potato-Cowpea intercropping system at FSRD Site, Noakhali during Rabi season of 2018-19

Treatment	Yield (t ha ⁻¹)		REY (t ha ⁻¹)	LER	GR (Tk. ha ⁻¹)	TVC (Tk. ha ⁻¹)	GM (Tk. ha ⁻¹)
	Sweet potato	Cowpea					
Sole Sweet potato	17.93	-	8.97	1.00	179333	50978	128355
Sole Cowpea	-	0.94	2.35	1.00	47166	16753	30413
Sweet potato + Cowpea (1:1)	8.63	0.54	5.67	1.07	112753	54854	57899
Sweet potato + Cowpea (2:1)	10.97	0.43	6.56	1.07	128144	53916	74228
Sweet potato + Cowpea (3:1)	14.59	0.33	8.12	1.16	162131	52885	109246
Sweet potato + Cowpea (4:1)	17.36	0.27	9.36	1.25	186462	51790	134672

Price (TK.Kg⁻¹): Sweet potato = 10, Cowpea = 50, Paddy=20

*GR=Gross Return, TVC=Total Variable Cost, GM=Gross Margin

REY and economic analysis of Sweet potato - Cowpea and Garlic+ Cowpea intercropped system are presented in Table 11.40. Based on results and discussion with the participants, the best performed treatments Sweet potato + Cowpea (4:1) and Garlic + Cowpea (3:1) were replicated in Rabi season, during 2019-2020. The REY and the gross margin in both intercropping systems were higher compared to base year. The REY and gross margin of Sweet potato + Cowpea (4:1) inter cropping system were found 9.95 t/ha and Tk.1,40,100 ha⁻¹. On the other hand the REY and gross margin of Garlic + Cowpea (3:1) intercropping system were

found 7.32t ha⁻¹ and Tk. 85,560 ha⁻¹ respectively. For cowpea with garlic intercropping is suitable for small-scale cultivation on land adjacent to homestead. On the contrary, cowpea with sweet potato intercropping system could be possible in large scale in the coastal areas as many farmers practicing sole sweet potato and sole cowpea in separate piece of land.

Table 11.40. REY and economic analysis of Sweet potato - Cowpea and Garlic + Cowpea intercropped system at FSRD Site, Subarnachar, Noakhali during Rabi season of 2018-19

Treatment	Yield (t ha ⁻¹)			REY (t ha ⁻¹)	GR (Tk ha ⁻¹)	TVC (Tk ha ⁻¹)	GM (Tk ha ⁻¹)
	Sweet potato	Garlic	Cowpea				
Sweet potato + Cowpea (4:1)	18.34	-	0.31	9.95	198,900	56800	1,40,100
Garlic+ Cowpea (3:1)	-	3.65	0.37	7.32	146,250	60690	85,560

Price (Tk.Kg⁻¹): Garlic = 35, Sweet potato = 10, Cowpea = 50, Paddy=20
GR=Gross Return, TVC=Total Variable Cost, GM=Gross Margin, BCR=Benefit Cost Ratio

11.2.11. Increasing yield through intercropping systems in Sugarcane at FSRD Site: Kaliganj, Satkhira (BRRI)

Yield and Economic analysis of different intercropping system presented in Table 11.41. Before intervention, farmers usually cultivated sole sugarcane which yielded about 68 t/ha. Gross margin from sole sugarcane cultivation was Tk. 113900 ha⁻¹ and the BCR was 1.92. After intervention (2019-20), Potato + Turnip and Potato + Khira were introduced as intercrop with sugarcane. The sugarcane equivalent yields (SEY) of the intercropping system were 151.36 t ha⁻¹ and 138.03 t ha⁻¹, respectively. Gross margin of intercropping system was 266400 ha⁻¹ and Tk. 241900 ha⁻¹ while the BCR was 2.01 and 2.00, respectively.

Intercropping system with sugarcane increased the total production and income more than double compared to sole crop production. The high yielding latest sugarcane variety was not available in that area. If they had better variety, the production could have increased almost double than the previous productions. Intercropping system provides better opportunity for farmers to improve their production rate. It will also create suitable alternative and crop diversity as well.

Table 11.41. Yield and economic analysis of different intercropping system at FSRD site, Kaliganj, Satkhira during 2019-2020

Observation	Intercropping system-1			Intercropping system-2			Sole crop
	Potato + Turnip	Sugarcane		Potato	Khira	Sugarcane	Sugarcane
Yield (t ha ⁻¹)	10.47	8.56	69.8	8.03	7.61	71	68
SEY (t ha ⁻¹)	44.87	36.69	69.8	34.41	32.61	71	68
Whole pattern SEY (t ha ⁻¹)	151.36			138.03			68
Gross return (Tk. ha ⁻¹)	157050	128400	244300	120450	114150	248500	238000
Total variable cost (Tk. ha ⁻¹)	78250	64370	120730	61800	56500	122900	124100
Gross margin (Tk. ha ⁻¹)	78800	64030	123570	58650	57650	125600	113900
Whole pattern Gross margin (Tk. ha ⁻¹)	266400			241900			113900
BCR	2.01			2.00			1.92

Unit price (Tk. kg⁻¹): Vegetables=15, Sugarcane=3.5, SEY = Sugarcane equivalent yield



Picture 11.19. Intercropping systems in sugarcane at FSRD Site, Kaliganj, Satkhira

11.2.12. Participatory variety selection trials on Aus Rice at FSRD site: Subarnachar, Noakhali (BARI)

In the participatory variety selection process, the most frequently preferred characteristics are high yielding, secondly short duration followed by stress tolerance such minimum tolerance to salinity (2 to 4 dSm⁻¹) or drought tolerance during initial stage of crop establishment. In addition, farmers preferred varieties with sturdy culms to avoid lodging and yield losses because of occasional rain and storms that occur during the dry season. Average yield of different Aus rice varieties of selected farmers are presented in Table 11.42. The highest yield (4.02 t ha⁻¹) was obtained from BRRRI dhan85 followed by Binadhan-19 (3.87 t ha⁻¹). Modern varieties should be incorporated with the cropping pattern with particular emphasis should be given on land types. For example, Binadhan-19 is suitable for medium high lands where drainage facility exist as huge rainfall occurred in trials site during reproductive stage of the variety. On the other hand, BRRRI dhan48 is not suitable for the lands where flooding depth exceed 0.8 meter as the variety is comparatively shorter than the other entities. Under such cases, BRRRI dhan85 is suitable for both types of land and could produce economically profitable yield. Furthermore, farmers preferred BRRRI dhan83 due to its short duration, grain color, and resistance to lodging as considered important for selection of rice variety for the dry season.

Table 11.42. Average yield of different Aus rice varieties at selected farmers of FSRD Site, Subarnachar, Noakhali during Kharif season of 2019 and 2020

Varieties	Mean Yield (t ha ⁻¹)	Crop duration (days)	Rank assigned by the respondents	Final Ranking
Hydra	2.24 (SD=0.177, Max. 2.40, min. 1.98)	102	7 (AS, QS)	7
BR26	3.53 (SD=0.042, Max. 3.60, min. 3.48)	111	6 (CWW, RL)	6
BRRRI dhan48	3.75 (SD=0.083, Max. 3.83, min. 3.58)	109	4 (HY, DC, GQ)	3
BRRRI dhan82	3.66 (SD=0.096, Max. 3.80, min. 3.51)	104	5 (DC, CWW)	5
BRRRI dhan83	3.68 (SD=0.067, Max. 3.73, min. 3.53)	105	3 (Hy, GD, GQ, RL)	4
BRRRI dhan85	4.02 (SD=0.154, Max. 4.21, min. 3.71)	110	1 (HY, CWW, RL, AS)	1
Binadhan-19	3.87 (SD=0.114, Max. 4.02, min. 3.68)	104	2 (HY, GD, GQ, AS)	2

*HY=Higher Yield, GQ= Grain quality for better market price or consumption, DC=Duration of crop, RL=Resistance to lodging, CWW = Capacity to withstand waterlogging (height), QS=Quality of straw for thatching/fodder/ fuel, AS=Salinity/drought tolerant



Picture 11.20. Different Aus rice varieties in Researcher led Participatory Variety Selection trials at FSRD Site, Noakhali during Kharif season (2019 and 2020)

11.2.13 Integrated Plant Nutrition System (IPNS) and Integrated Pest Management (IPM) approaches for watermelon cultivation at FSRD Site: Subarnachar, Noakhali (BARI)

Yield and economic performance of watermelon production under different cultivation practices are presented in Table 11.43. The highest fruit yield (25.42 t ha⁻¹) and gross margin (Tk.140594 ha⁻¹) were found from IPNS +IPM system which was 13.63% and 59.94% higher over farmer's practices (imbalance use of chemical fertilizers along with 20 to 25 times insecticides spray). Integrated Plant Nutrition System (IPNS) resulted lower use of inorganic fertilizers, eventually helped to improved soil health. On the other hand, integrated Pest Management (IPM) combination brought down the infestation rate of *Bactrocera cucurbitae* which facilitated to reduced deformed shape fruits within the fields with increased the quality harvested marketable fruits. Increased harvested marketable quality good shaped fruits by application of bio-pesticides. Moreover, bio-pesticides along with sticky traps helped to withdrawal insecticide spray frequencies and cost of production reduced more than 10930- Tk.17398 ha⁻¹.

Table 11.43 Comparison of yield and economic performance of watermelon production under different cultivation practices at FSRD Site, Subarnachar, Noakhali during 2019 and 2020

Cultivation Practices	Year	Av. Yield (t ha ⁻¹)	Fruit fly infestation (%)	GR (Tk. ha ⁻¹)	TVC (Tk. ha ⁻¹)	GM (Tk. ha ⁻¹)
IPNS system +IPM system	2018	24.34	≤ 7	243,400	116,890	126,510
	2019	26.51		265100	110422	154678
Average		25.42		254250	113656	140594
Adjacent farmers practices (imbalance use chemical fertilizers along with 20 to 25 times insecticides spray)	2018	21.80	≥20	218,000	127820	90,180
	2019	22.94		2,29,400	143780	85620
Average		22.37		223700	135800	87900

Price (TK.per Kg): Watermelon=10 *GR=Gross Return, TVC=Total Variable Cost, GM=Gross Margin



Picture 11.21. Watermelon production at FSRD Site, Subarnachar, Noakhali

11.2.14. On-Farm Verification Trials on different crops variety at FSRD Site: Subarnachar, Noakhali and Jamla, Patuakhali (BARI)

Yield and economic returns of on-farm verification trials conducted during 2018-2021 at FSRD site, Subarnachar, Noakhali are presented in Table 11.44.

Noakhali:

Boro rice: The average yield of Binadhan -10 was 4.3 t ha⁻¹ which gave Tk. 25, 850 ha⁻¹ as gross margin. However, marginal farmer cultivated Boro rice for their own food security whereas medium farmers only practiced Boro rice cultivation when the prices become high.

Soybean: The lion shares of the soybean cultivating areas located in greater Noakhali region where more than eighty (80) percent farmers adopting Shohag variety which was released in 1992. In the course of time

BARI developed three varieties such as BARI Soybean-5, BARI Soybean-6 and BARI Soybean-7 which is planted by some 5 to 10 percent of soybean farmers. BARI Soybean-5 was used in this study. Line sowing method was practiced in the trials and the average yield was found 1.82 t ha⁻¹ which offered Tk. 25,565 ha⁻¹ as gross margin.

Mungbean: The average yield 0.94 t ha⁻¹ was obtained from BARI Mung-6 with higher gross margin Tk. 28,530 ha⁻¹ due to line sowing method was practiced.

Cowpea: Farmers of Noakhali broadcasted cowpea in the less fertile soils. During the *Rabi* season of 2018-19, cowpea was sown in line sowing methods. The average yield 0.89 t ha⁻¹ was obtained from BARI Felon-1 with higher gross margin Tk. 20216 ha⁻¹ due to line sowing method was practiced.

Grasspea: Grasspea ranks first among the pulses in respect of area and production in Bangladesh. In southern belt, grasspea is generally grown as relay crop with T. Aman without fertilizers. Due to salinity tolerant capability BARI Ksheshari-2 were selected in the location. Farmers of Noakhali practiced relay cropping method where soil salinity remain high during December to January and sustaining of other crops become limited. The average yield of BARI Ksheshari-2 was found 0.895 t ha⁻¹ with gross margin Tk. 19,508 ha⁻¹

Sunflower: In Bangladesh, attempts of sunflower cultivation have been initiated and area of production is increasing. Now it is being grown in 16 districts of Bangladesh. From On-Farm Verification Trials the average yield of BARI Surjomukhi-2 was found 1.2 t ha⁻¹ with gross margin Tk. 21136 ha⁻¹. There is a great scope for growing sunflower after harvest of T. Aman rice, because it is considered as moderately salt and drought tolerant crop.

Proso millet: In moderate to strong saline soils which remains fallow during *Rabi* season before project intervention. Crops varieties such as BARI Cheena-1 found more promising compared to other crops cultivation in saline soil. This trial was conducted in the highly saline soil condition and more than 0.95 t ha⁻¹ yields was found which offered gross margin Tk. 23721 ha⁻¹.

Potato: Climate smart heat tolerant BARI Alu -41 was cultivated among six farmers from different categories at FSRD site, Subarnachar, Noakhali during *Rabi* season of 2019-2020. After planting, the plot was covered by the water hyacinth (@ 68 t ha⁻¹). The average tuber yield of potato was 13.10 t ha⁻¹. Along with all the on-farm verification trials highest gross margin (Tk. 54,500 ha⁻¹) was observed in potato production with water hyacinth mulch.

Groundnut: At the Noakhali site groundnut variety Dhaka-1 was chosen due to short duration. The average pod yield of Dhaka-1 was found 1.20 t ha⁻¹ which provided a considerable gross margin (Tk. 29,622 ha⁻¹) in on verification trial during the *Rabi* season.

Mustard: Short duration BARI Sarisha-14 was selected as the variety is almost self-compatible type which helps to produce considerable yield at adverse weather condition during flowering stage. The variety gave better seed yield (0.76 t ha⁻¹) than that of national average (650 Kg ha⁻¹) in the locations. The gross margin was recorded Tk. 15620 ha⁻¹.

Wheat: Sowing of wheat is often late in the southern coastal areas because of delayed harvesting of T. Aman rice, longer time for land preparation, unavailability of labourers, late monsoon and some cases of excess moisture in the soil. However, one farmer of medium group became interested to cultivate wheat in the *Rabi* season. Based on farmer's interest, BARI Gom-25 was selected as planting materials due to moderate level of tolerance to terminal heat stress giving 6-10% higher yield under late seeding and moderately tolerant to salinity (less than 10 dS/m). The result of the trials, revealed that the grain yield of wheat was 1.28 t ha⁻¹ which offered Tk. 20750 ha⁻¹ as gross margin.

Table 11.44. Average yield and economic analysis of different Rabi crops in On-farm verification trials conducted at FSRD site, Subarnachar, Noakhali

Crops	Varieties	Avg. Yield (t ha ⁻¹)	GR (TK.ha ⁻¹)	TVC (TK.ha ⁻¹)	GM (TK.ha ⁻¹)
Boro Rice	Binadhan-10	4.30	95,600	69,750	25,850
Soybean	BARI Soybean-5	1.82	54,600	29,035	25,565
Mungbean	BARI Mung-6	0.94	56,400	27,870	28,530
Cowpea	BARI Felon-1	0.89	44,500	24,284	20216
Grasspea	BARI Khesari-2	0.92	32,200	12692	19,508
Sunflower	BARI Surjomukhi-2	1.21	48,400	27264	21136
Proso millet	BARI Cheena-1	0.95	38,000	14289	23721
Potato	BARI Alu-41	13.10	1,31,000	76500	54500
Ground nut	Dhaka-1	1.20	72,000	42378	29622
Mustard	BARI Sarisha-14	0.76	30,400	14780	15620
Wheat	BARI Gom-25	1.28	38,400	17650	20750

Farmgate Selling Price (TK.Per Kg): Paddy=20, Soybean=30, Mungbean=60, Cowpea=50, Grass pea=35, Sunflower=40, Proso millet=40, Potato=10, Wheat= 30 and Mustard=40

Yield and cost return analysis of on-farm verification trials conducted during 2018-2021 at FSRD site, Jamla, Patuakhali are presented Table 11.45.

Patuakhali:

Sunflower: Farmers of Patuakhali, practiced Hybrid sunflower cultivation more than 12 years and the crop have usual marketing facility. BARI Surjomukhi-2 was planted in traditional line sowing method. The average yield and gross margin were found 1.30 t ha⁻¹ and Tk. 42,500 ha⁻¹, respectively during *Rabi* season.

Mungbean: The southern coastal belt is a major mungbean growing areas of Bangladesh. The high yielding and short duration BARI Mung-6 was cultivated with the cooperators farmers in the location. The On Farm verification trial was conducted in the farmer's field. The average grain yield of BARI Mung-6 was found 1.42 t ha⁻¹ with higher gross margin Tk. 56,000 ha⁻¹ due to line sowing method was practiced.

Maize: The popularity of maize and area under cultivation are increasing rapidly in Patuakhali region because of its diversified uses, increasing demand from poultry industry, higher nutritive value, higher per hectare yield and net benefit than other cereals. BARI Hybrid Maize-9 was cultivated in On Farm verification trial during *Rabi* season. The On Farm verification trial was conducted in two farmer's field. The average grain yield of BARI Hybrid Maize-9 was found 7.92 t ha⁻¹. Second highest gross margin (Tk. 88,200 ha⁻¹) was found from BARI Hybrid Maize-9 due to its higher yield potentiality.

Chilli: One farmer from marginal group was engaged in chilli cultivation where BARI Morich-1 was used along with improved agronomic practices. The yield was 1.90 t ha⁻¹ and the gross margin (Tk.59,400 ha⁻¹) was ranked as third comparing to other On-Farm verification trials.

Groundnut: BARI Chinabadam-8 was selected for Patuakhali region due to higher yield with moderate duration. The average seed yield of BARI Chinabadam-8 was 2.80 t ha⁻¹ which represented the highest gross margin (Tk. 104800 ha⁻¹) over all the on-farm verification trials conducted at Patuakhali site.

Cowpea: Cowpea is one of the most preferred crops and a valuable component in the farming systems of the majority of resource poor rural households in the coastal areas of Bangladesh. Farmers usually cultivated it in limited scale for household consumption and sold additional product. BARI Felon-1 was selected as planting material where line sowing was done along with recommended fertilizer doses. It produced (1.10 t ha⁻¹) and farmers earned Tk.30,945 ha⁻¹.

Grasspea: Due to salinity tolerant capability BARI Khesari-2 were selected in the location. Farmers of

Patuakhali practiced relay cropping method where soil salinity remain high during December to January and sustaining of other crops become limited. The average yield of BARI Khesari-2 was found 0.92 t ha⁻¹ with gross margin Tk. 17,370 ha⁻¹.

Mustard: Short duration BARI Sarisha-14 was selected as the variety is almost self-compatible type which helps to produce considerable yield at adverse weather condition during flowering stage. The variety gave better seed yield (0.96 tha⁻¹) than that of national average (650 Kg ha⁻¹) in the locations. The gross margin was recorded Tk. 20,800 ha⁻¹.

Table 11.45. Average yield and Economic return of different on-farm verification trials at FSRD sites, Jamla, Patuakhali during Rabi season of 2019-20

Crops	Varieties	Avg. Yield (t ha ⁻¹)	GR (TK.ha ⁻¹)	TVC (TK.ha ⁻¹)	GM (TK.ha ⁻¹)
Sunflower	BARI Surjamukhi-2	1.30	65,000	22,500	42,500
Mungbean	BARI Mung-6	1.42	71,000	15,000	56,000
Maize	BARI Hybrid Maize-9	7.92	1,78,200	90,000	88,200
Chilli	BARI Morich-1	1.90	1,14,000	54,600	59,400
Groundnut	BARI Chinabadam-8	2.80	168,000	63,200	10,4800
Cowpea	BARI Felon-1	1.10	55,000	24,055	30,945
Grasspea	BARI Khesari-2	0.92	36,800	19,430	17,370
Mustard	BARI Sarisha-14	0.96	57,600	36,800	20,800

Farmgate selling Price (Tk per Kg): Maize=22.50, Mungbean=50, Sunflower=50,Chilli=60, Groundnut=60, Cowpea=50, Grasspea=40, Mustard=60

Yield and economic analysis of on-farm verification trials conducted by Power Tiller Operated Seeder during 2018-2021 at FSRD site, Noakhali and Patuakhali are presented Table 11.46.

Mungbean: During *Rabi* season of 2019-2020, PTOS was used in both the location, where 1.12 and 1.52 t ha⁻¹ was found from BARI Mung-6 cultivation in Noakhali and Patuakhali, respectively. In Patuakhali, sowing by PTOS reduced about Tk. 8000 ha⁻¹ sowing cost and averagely 69% gross margin increased over broadcasting and line sowing method observed in the on-farm verification trial. Though sowing cost reduced minimum in PTOS method in Noakhali site, but 39% gross margin increased over traditional broadcasting method observed during 2019-2020 (Table 11.46).

Cowpea: The seed yield of cowpea was increased about 30% by PTOS method which offered an additional Tk. 41550 ha⁻¹ at Noakhali.

Soybean: BARI developed Power tiller operated seeder for sowing different kinds of Rabcrops. PTOS performs three functions i.e., ploughing, seeding in rows, and laddering, simultaneously which reduced land preparation cost and reduced seeds rate as compared with traditional practices. In both the locations, farmers practiced broadcasting method for sowing of oil seed and pulses crop which costs less, but ultimate income is also less due to higher intercultural operation costs and lower grain yields. On the other hand, PTOS were used during 2019-2020 for sowing BARI Soybean-6 variety, yielded 2.06 t ha⁻¹ where sowing cost was reduced about Tk. 2000 ha⁻¹ and gross margin was increased averagely 19% over broadcasting and line sowing methods.

Table 11.46. Performance of Power Tiller Operated Seeder in different crops production at different FSRD sites under coastal ecosystem

Location	Crop	Area (ha) & Farmers No.	Yield (t ha ⁻¹)		Sowing cost (Tk. ha ⁻¹)		Gross Return (Tk. ha ⁻¹)		Gross Margin (Tk. ha ⁻¹)	
			PTOS	FP	PTOS	FP	PTOS	FP	PTOS	FP
Patuakhali	Mungbean (BARI Mung-6)	3.34 (08)	1.52	1.19 (B)	5613	9880 (B)	76000	59500	70387	49620
	Sunflower	01 (6)	1.78	1.25 (L)		17290 (L)	89000	62500	88437	45210
Noakhali	Soybean (BARI Soybean -6)	5.73(08)	2.06	1.68 (B)	6516	7459 (B)	61800	50400	55284	42941
				1.97 (L)		9360 (L)		59100		49740
	Mungbean (BARI Mung-6)	1.82 (06)	1.12	0.86 (B)	8120	8570 (B)	67200	51600	59800	43030
	Cowpea (BARI Felon-1)	1.70 (07)	0.98	0.76 (B)	8185	7450 (B)	49000	38000	41550	30550

Price (Tk per Kg): Noakhali- Soybean=30, Mungbean=60, Cowpea=50; Patuakhali- Mungbean=50, Sunflower=50*Picture in the parentheses are farmers' number; PTOS=Power Tiller Operated Seeder, FP=Farmers Practice, B= Broadcasting method, L=Line sowing method by hand



Picture 11.22. Different on-farm verification trials at FSRD sites Noakhali and Patuakhali

11.2.15. Production program of Aus rice at FSRD Site: Noakhali and Patuakhali (BARI)

Yield and cost return of Aus Rice variety under production program are presented in Table 11.47. The average yield of BRRRI dhan48 at Patuakhali and Noakhali were 3.93t ha⁻¹ and 3.43 t ha⁻¹, respectively, during *Kharif* season (2019 and 2020) which is much higher compared to Noakhali site. Cooperatively higher gross margin (Tk. 24400 ha⁻¹) was obtained at Patuakhali site. It was clearly observed that BRRRI dhan48 could be incorporated in the cropping patterns.

Table 11.47. Yield, cost and return of Aus Rice variety at FSRD Sites, Noakhali and Patuakhali during Kharif season of 2019 and 2020

Location	Variety	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Gross return (Tk. ha ⁻¹)			Cost of production (Tk.ha ⁻¹)	Gross margen (Tk.ha ⁻¹)
				Grain	Straw	Total		
Noakhali	BRRRI dhan48	3.43	3.1	71200	3400	74600	53400	21200
Patuakhali		3.93	3.4	86000	3100	89100	64500	24600

*Market price of output (Tk.Kg⁻¹): Rice= 20.00 and Straw= 1.00



Picture 11.23. Aus rice production at FSRD Site, Subarnachar Noakhali during Kharif season (2019 and 2020)

11.2.16. Production program on T. Aman varieties for cropping patterns at FSRD Site: Noakhali and Patuakhali (BARI)

Yield and cost return analysis of different T. Aman rice varieties under production program are presented in Table 11.48. Among the cooperator farmers BR23, BRRRI dhan52 and BRRRI dhan87 were cultivated during *Kharif II* season of 2019 and 2020. The varieties were selected on the basis of land types, water stagnant duration and drainage conditions. In 2019, BRRRI dhan52 gave highest yield (4.34 t ha⁻¹) whereas second highest yield (4.3 t ha⁻¹) was obtained from BRRRI dhan87. The lowest yield (3.96 t ha⁻¹) was obtained from BR23. During 2020, BRRRI dhan87 gave the highest yield compared to other two varieties. Moreover, BRRRI dhan87 is short duration compare to other varieties. It was observed that, BRRRI dhan87 is suitable for slightly high land and fit in to the cropping pattern: watermelon - green manuring crops-T. Aman and Groundnut -T. Aus -T. Aman. Considering the cost return analysis, it was found that BRRRI dhan87 cultivation was more profitable but suitable lands are widely differed from other two varieties.

Table 11.48. Yield of different T. Aman rice varieties at FSRD Site, Subarnachar, Noakhali during Kharif II season of 2019 and 2020

Varieties	Year	Mean Yield (t ha ⁻¹)	Gross return (TK.ha ⁻¹)			Cost of production (TK.ha ⁻¹)	Gross margin (TK.ha ⁻¹)
			Grain	Straw	Total		
BRRi dhan52	2018	4.09	81,800	8820	90620	62000	28,620
	2019	4.34	86800	8960	95760	63000	32,760
	2020	4.12	82400	9020	91420	61250	30,170
	Average	4.18	83,667	8,933	92,600	62083	30,517
BR23	2019	3.96	79,200	9140	88,340	58520	29,820
	2020	3.92	78,400	8920	87,320	57800	29,520
	Average	3.94	78,800	9,030	87,830	58,160	29,670
BRRi dhan87	2019	4.30	86,000	8740	94,740	62250	32,490
	2020	4.19	83,800	9180	92,980	63000	29,980
	Average	4.25	84,900	8,960	93,860	62,625	31,235

Market price of output (TK.Kg⁻¹): Rice= 20 and Straw= 2.00



Picture 11.24. Different T. Aman rice varieties production at FSRD Site, Subarnachar, Noakhali

Average yield of different T. Aman rice varieties under production program at Patuakhali during *Kharif II* season (2018, 2019 and 2020) are presented in the Table 11.49. The highest yield (4.71 t ha⁻¹) was found from BRRi dhan52 whereas farmers prefer BR11 and BR23 as water level in the field was high during the growing season (Aman season). On the other hand, yield of BRRi dhan52 decreased and highest (4.57 t ha⁻¹) obtained from BR11 and BR23 performed the lowest yield in both the year. In 2020 cropping year, BRRi dhan52 gave highest (4.25 t ha⁻¹) yield followed by BRRi dhan49 with 4.21 t ha⁻¹. Moreover, BRRi dhan76 produced third highest yield among four tested varieties.

Table 11.49. Average yield of different T. Aman rice varieties at FSRD site, Jamla, Patuakhali during Kharif II season of 2019 and 2020

Year	Varieties	Mean Yield (t ha ⁻¹)	Gross return (TK.ha ⁻¹)			Cost of production (TK.ha ⁻¹)	Gross margin (TK.ha ⁻¹)
			Grain	Straw	Total		
2018	BR11	3.32	66400	2260	68660	53120	15540
	BR23	4.01	80200	3790	83990	60150	23840
	BRRi dhan52	4.71	94200	2680	96880	61230	35650
2019	BR11	4.57	91400	2480	93880	51320	42560
	BR23	3.96	79200	3650	82850	61050	21800
	BRRi dhan52	4.34	86800	2850	89650	60230	29420
2020	BR23	3.95	79,000	3,950	82,950	59200	23,750
	BRRi dhan52	4.25	85,000	2,980	87,980	60,200	27,780
	BRRi dhan76	4.11	82,200	3,010	85,210	58800	26,410
	BRRi dhan49	4.21	84,200	3410	87,610	59,400	28,210

Market price of output (TK.Kg⁻¹): Rice= 20.00 and Straw= 1.00

11.2.17. Quality seed production of Soybean in Kharif II season at FSRD Site: Subarnachar, Noakhali (BARI)

Yield and economic return in quality seed production of Soybean during late *Kharif II* season are presented in Table 11.50. The trial was conducted at FSRD site, Noakhali during late *Kharif- II* season of 2018-2020. The average yield of two years was found 1.63 t ha⁻¹. More over, average gross return, variable cost and gross margin were recorded Tk.1,20,977 ha⁻¹, Tk. 41, 523 ha⁻¹ and Tk. 79454 ha⁻¹, respectively. The quality of the seed was increased as produced seeds had higher percentages of normal seedlings in the germination test compared to last year Rabi season seeds which preserved by the farmers.

Table 11.50. Yield and economic return in quality seed production of Soybean during late Kharif II season for upcoming Rabi season at FSRD Site, Subarnachar, Noakhali

Years	Avg. Plot size (dec.)	Seed rate (kg ha ⁻¹)	Date of sowing	Date of harvesting	Yield (t ha ⁻¹)	Gross return (Tk.ha ⁻¹)	Variable cost (Tk.ha ⁻¹)	Gross margin(Tk .ha ⁻¹)
2018-2020	0.60	55	19-29 August	07-17 December	1.63	1,20,977	41,523	79454

11.2.18. Production program of BRRI released T. Aman and Boro rice varieties in coastal ecosystem at FSRD Site:Kaliganj, Satkhira (BRRI)

A. T. Aman rice

Yield, cost and return analyses of newly released varieties of T. Aman are presented in Table 11.51 during 2018-2020. Average grain yield of BRRI dhan87 (5.64 tha⁻¹) was little bit higher than other varieties followed by BRRI dhan71 (5.55 tha⁻¹), BRRI dhan75 (5.36 tha⁻¹). BRRI dhan76 gave lower grain yield (4.29 tha⁻¹) where BRRI dhan52 and BRRI dhan73 produced very similar of 5.17 tha⁻¹ and 5.15 tha⁻¹, respectively.

The average BCR of three consecutive year for BRRI dhan71, BRRI dhan87, BRRI dhan52, BRRI dhan75, BRRI dhan73 and BRRI dhan76 were 2.11, 2.08, 2.06, 2.05, 1.94 and 1.78 while the gross margin was Tk. 65100 ha⁻¹, Tk. 65450 ha⁻¹, Tk. 59535 ha⁻¹, Tk. 61433 ha⁻¹, Tk. 56367 ha⁻¹ and Tk. 43350 ha⁻¹, respectively.

Table 11.51. Yield, cost and return analysis of T. Aman rice varieties at FSRD site, Kaliganj, Satkhira during T. Aman season, 2018-2020

Variety	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Gross return (Tk./ha)			Total variable cost (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
			Grain	Straw	Total			
BRRI dhan52	5.17	4.30	103300	12855	116155	56620	59535	2.06
BRRI dhan71	5.55	4.33	110933	13000	123933	58833	65100	2.11
BRRI dhan73	5.15	4.3	103067	12900	115967	59600	56367	1.94
BRRI dhan75	5.36	4.3	107133	13000	120133	58700	61433	2.05
BRRI dhan76	4.29	4.4	85800	13200	99000	55650	43350	1.78
BRRI dhan87	5.64	4.4	112800	13200	126000	60550	65450	2.08

Unit price (Tk. kg-1): Rice=20.00, Rice straw =3

B. Boro rice

Yield, cost and return analysis of newly released varieties of Boro rice are presented in Table 11.52. The average yield of BRRI dhan67, BRRI dhan81, BRRI dhan84, BRRI dhan86, BRRI dhan88 and BRRI dhan89 were 6.09 t ha⁻¹, 6.22 t ha⁻¹, 6.12 t ha⁻¹, 6.04 t ha⁻¹, 6.37 t ha⁻¹ and 6.51 t ha⁻¹, respectively grown during Boro season of 2018-20. The gross margins of these tested varieties were Tk. 68415 ha⁻¹, Tk. 70800 ha⁻¹, Tk. 67750 ha⁻¹, Tk. 68450 ha⁻¹, Tk. 71600 ha⁻¹, and Tk. 75100 ha⁻¹, respectively. BCR for BRRI dhan67, BRRI dhan81, BRRI dhan84, BRRI dhan86, BRRI dhan88 and BRRI dhan89 were 2.02, 2.05, 1.99, 2.04, 2.02 and 2.08, respectively.

In the field trials, BRRI dhan75 in T. Aman and BRRI dhan67 in Boro season were very popular among the farmers. BRRI dhan75 has better grain quality with shorter growth duration help to quick dissemination this variety among the farmers. During 2020 season, almost 8.0 ha of T. Aman were cultivated by their own collected seeds. BRRI dhan67 quickly gained popularity among the farmers especially in saline area. During 2018-19, farmers stored their seeds and disseminated to other farmers. Some of the other varieties such as BRRI dhan73, BRRI dhan81 BRRI dhan86 and BRRI dhan87 were also popular among the farmers. Farmers are now storing their seeds for next season with the help of our motivation and storage drums given by the project.

Table 11.52. Yield, cost and return analysis of Boro rice varieties at FSRD site, Kaliganj, Satkhira during Boro season, 2018-20

Variety	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Gross return (Tk/ha)			Total variable cost (Tk.ha ⁻¹)	Gross margin (Tk.ha ⁻¹)	BCR
			Seed	Straw	Total			
BRRI dhan67	6.09	4.65	121800	13950	135750	67335	68415	2.02
BRRI dhan81	6.22	4.68	124400	14025	138425	67625	70800	2.05
BRRI dhan84	6.12	4.55	122400	13650	136050	68300	67750	1.99
BRRI dhan86	6.04	4.50	120800	13500	134300	65850	68450	2.04
BRRI dhan88	6.37	4.7	127400	14100	141500	69900	71600	2.02
BRRI dhan89	6.51	4.8	130200	14400	144600	69500	75100	2.08

Unit price (Tk. kg⁻¹): Rice=20.00, Rice straw =3



Picture 11.25. Production program of T. Aman and Boro rice at FSRD site, Kaliganj, Satkhira during 2018-20

11.2.19. Production program on BINA released different crops variety at FSRD Site: Shyamnagar, Satkhira (BINA)

Rice: The average yield of Binadhan-11 was 4.92 t ha⁻¹ with gross return was Tk. 98020 ha⁻¹. The total cost of production, gross margin was Tk. 54530 ha⁻¹ and Tk. 43490 ha⁻¹ respectively. The Benefit Cost Ratio was 1.8 (Table 11.53)

Table 11.53. Yield, cost and return analysis under production program of Binadhan-11 at FSRD Site, Shyamnagar, Satkhira

Variety	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Gross return (Tk. ha ⁻¹)			Cost of production (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
			Grain	Straw	Total			
Binadhan-11	4.92	4.73	88560	9460	98020	54530	43490	1.8

Mustard: Production program on mustard was conducted in the farmer's field of the FSRD site, Shyamnagar, Satkhira during *Rabi* season 2020-21. The mustard variety Binasharisa-4 and Binasharisa-9 were used in this production program. The number of farmers was six. The area covered by Binasharisa-4 and Binasharisa-9 were 1.5 ha and 2.0 ha, respectively. The average yield of Binasharisa-4 and Binasharisa-9 was observed 1.43 and 1.41 t ha⁻¹ respectively along with gross margin in 30952 and Tk.32572 ha⁻¹. The benefit cost ratio was found 1.94 and 1.93 for Binasharisa-4 and Binasharisa-9 (Table 11.54).

Farmers' opinion: Farmers are very much impressed having short duration and the higher yield of Binasharisa-4 and a good amount of seed has been stored by the farmers for growing in the next year.

Table 11.54. Yield and cost return analysis of mustard varieties under production program at FSRD Site, Shyamnagar, Satkhira during 2020-2021

Variety	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Gross return (Tk.ha ⁻¹)			Cost of production (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
			Grain	Straw	Total			
Binasharisa-4	1.43	3.2	63450	6400	69850	35875	33975	1.94
Binasharisa-9	1.41	3.0	63450	6000	69450	35981	33469	1.93

Grasspea: Production program on grasspea was conducted in the farmer's field of the FSRD site, Shyamnagar, Satkhira during *Rabi* season 2020-21. The grasspea variety Binakheshari-1 was used in this production program. The number of farmers was six. The area covered by Binakheshari-1 was 2.0 hectare. The average yield of Binakheshari-1 was found 1.52 t ha⁻¹ along with gross margin in Tk. 66110 ha⁻¹. The benefit cost ratio was found 3.75 (Table 11.55).

Farmers' opinion: Farmers are very much impressed having higher yield of Binakheshari-1 and a good amount of seed has been stored by the farmers for growing in the next year.

Table 11.55. Yield and cost return analysis of grasspea varieties under production program at FSRD Site, Shyamnagar, Satkhira during 2020-2021

Variety	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Gross return (Tk. ha ⁻¹)			Cost of production (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
			Grain	Straw	Total			
Binakheshari-1	1.52	2.71	80560	9550	90110	24000	66110	3.75

11.3. Livestock Component

Livestock are the important and valuable asset of farmers especially during critical on unfavorable ecosystem. Livestock and poultry rearing are common practices in the site. Livestock and poultry disease is the main problem faced by the farmers for livestock and poultry birds rearing. Only proper vaccination can reduce the mortality rate of livestock and poultry birds. To reduce mortality of livestock and poultry birds were vaccinated during 2018-2020. FMD and Anthrax vaccines for cattle; BCRDV, RDV and Fowl pox vaccine for chicken and Duck plague vaccine for ducks were used as per recommended schedule.

11.3.1. Vaccination of livestock of co-operative farmers at FSRD Site: Subarnachar, Noakhali (BARI)

A total of 404 cattle, 12 buffalo were vaccinated against FMD and Anthrax disease; 95 goats were vaccinated against PPR diseases at FSRD site, Subarnachar, Noakhali during February 2018- December 2020 (Table 11.56). It was found that before vaccination, frequency and mortality rate of different disease of cattle, buffalo and goat was about 2-7% (Avg.4.1%). After vaccination of cattle it was reduced to 0-2, (Avg. 0.88%). Farmers were interested to continue vaccination, but it was very difficult to continue the program without local service provider.

Table 11.56. Mortality (%) of livestock before and after vaccination against major diseases at FSRD site Subarnachar, Noakhali during 2018 – 2021

Year of vaccination	Name of diseases	No. of livestock Vaccinated			Mortality (%)	
		Cattle	Goat	Buffalo	Before vaccination	After vaccination
Year I	Anthrax	45	-	03	4	0
	FMD	45	-	03	2	0
	PPR	-	18		7	1
Year II	Anthrax	75	-	03	5	2
	FMD	75	-	03	2	0
	PPR	-	35	-	5	1
Year III	Anthrax	82	-	-	5	0
	Foot and Mouth	82	-	-	2	2
	PPR	-	42	-	5	2
	Total	404	95	12	Avg.4.1	Avg. 0.88

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



Picture 11.26. Vaccination program at FSRD Site, Subarnachar, Noakhali

11.3.2. Vaccination program on cattle at FSRD Site Jamla, Patuakhali (BARI)

For improvement of cattle health and to reduce mortality by proper vaccination is needed against major diseases. Anthrax and FMD vaccines were injected as per recommended schedule at the FSRD site of Patuakhali. It was observed that among the vaccinated cattle no anthrax disease was found and incidence of foot and mouth disease was only 01% that is 88% lower than before of vaccination (Table 11.57).

Table 11.57. Effect of cattle vaccination at FSRD site, Jamla, Dumki, Patuakhali

Diseases	Number of cattle vaccinated	Before vaccination (%)	After vaccination (%)
Anthrax	40	05	0
Foot and Mouth	40	09	01

11.3.3 Vaccination program on goat at FSRD Site: Kaliganj, Satkhira (BRII)

PPR disease is a contagious respiratory viral disease of sheep's and goats. If no vaccination is done it can be economically disastrous to small and medium scale farmers as this disease mortality rate can be close to 100%. To reduce disease occurrence in goats' PPR vaccination programs were conducted at FSRD site. Twenty goats were vaccinated against PPR disease of goat on 2nd June, 2020. Before the vaccination, mortality rate due to PPR diseases in the area was 30% but after vaccination no mortality was recorded (Table 11.58).

Table 11.58. Mortality (%) of goats before and after vaccination against PPR disease at FSRD site Kaliganj, Satkhira

Date of vaccination	Name of the vaccine	Number of goats vaccinated	Mortality (%)	
			Before vaccination	After vaccination
June,2020	PPR	20	30%	0%

11.3.4. Vaccination program on livestock at FSRD site: Shyamnagar, Satkhira (BINA)

A total number of 694 livestock were vaccinated in the project area during February 2019-December 2020 (Table 11.59). Among them 475 and 219 cattle and goat are vaccinated against major diseases like FMD and Anthrax for cattle and PPR for goat. It was observed that before vaccination, frequency of different disease was higher. It was found that before vaccination mortality rate of livestock due to different diseases was higher 8-15% (Avg.11.25). After vaccination all the diseases reduced drastically and mortality was recorded 0-5% (Avg.2.75). Farmers were interested to continue vaccination program of cattle and goat.

Table 11.59. Mortality (%) of livestock before and after vaccination against major diseases at FSRD Site Shyamnagar, Satkhira during Feb. 2018- Jan. 2021

Year of vaccination	Name of the disease	Livestock		Mortality (%)	
		Cattle	Goat	Before vaccination	After vaccination
Feb 2019- Jan.2020	FMD and Anthrax	146		10	1
	PPR		87	15	5
Feb 2020- Dec.2020	FMD and Anthrax	329		08	0
	PPR		132	12	5
Total		475	219	Avg.11.25	Avg.2.75

11.3.5. Improvement of cattle health by de-worming and vaccination at FSRD Site: Jamla, Patuakhali (BARI)

De-worming followed by vaccination program was carried out at the FSRD sites, Jamla, Dumki, Patuakhali throughout the project period. Thirty cattle including 03 milking cows owned by the cooperative farmers were selected for de-worming and vaccination (Table 11.60). Second dose of de-worming was given 35-40 days interval as per body weight of the cattle recommended by concerned personnel of ULO, Dumki, Patuakhali. After de-worming milking rate per day was increased and body weight was gained (Table 11.61). It was observed that de-worming is an easy process to adopt with minimum cost.



Picture 11.27. De-worming and vaccination at FSRD Site: Jamla, Patuakhali

Table 11.60. Livestock covered by de-worming and vaccination program at FSRD site Jamla, Dumki, Patuakhali

Livestock Type	De-worming	Vaccination
Cattle	30	Anthrax (30), Foot and Mouth (30)

Table 11.61. Effect of de-worming and vaccination on body weight, average lactation yield and lactation period of cattle at FSRD Site, Jamla, Patuakhali

Treatment	Animal (no)	Avg. Body wt. gain day ⁻¹ animal ⁻¹ (g)	Avg. Lactation yield (L day ⁻¹)	Avg. Lactation period(day)
Controlled Cattle	03	70	1.5	180
De-wormed Cattle	03	110	2.25	205

11.3.6. Calf rearing at FSRD Site: Jamla, Patuakhali (BARI)

Five co-operative farmers were engaged in calf rearing. They bought calf from local market and brought up them in their yard with locally available fodder and residue of homestead. At the time of Eid-Ul-Azha such type of cattle demand is higher than that comes from other areas. By calf rearing the farmers earned an average Tk. 37850 cattle¹ (Table 11.62).



Picture 11.28. Calf rearing at FSRD Site: Jamla, Patuakhali

Table 11.62. Income from calf rearing at FSRD Site: Jamla, Patuakhali during 2019-20

Name of Farmers	No. of calf	Rearing cost	Income (Tk.)	Net Income (Tk.)
Abdul Mannan Khan	02	28500	76000	47500
Anwar Hossain Mrida	02	36000	81000	45000
Manik Hawlader	01	12400	35000	22600
Paresh Chandra	02	32000	87000	55000
Kabir Hossain	01	9500	28000	19000

Avg. income= Tk.37850

11.3.7. Beef fattening as a source of income generation at FSRD site: Shyamnagar, Satkhira (BINA)

Now a days, beef fattening is very popular and profitable business if it can be done scientifically. Five cattle were selected for beef fattening program. Performance of beef fattening program presented in Table 11.63. Initial body weight was 29-62 kg (Avg. 38 kg) and purchase value was (Tk.18700- Tk. 35000). After 180 days it was observed that body weight of the cattle was increased over initial from 42-66%. At the same time, market value of each cattle was increased 48-81%. Present value of the cattle ranges from Tk.31500- Tk.68000 (Table 11.63).

Table 11.63. Body weight and market value after 180 days fattening of cattle at FSRD Site, Shyamnagar, Satkhira during June 2020- January 2021

Farmer's Name	No. of cattle	Initial body wt. (kg)/cattle	Body wt. after 180 days (kg)	Body wt. increase over Initial (%) /cattle	Initial value (Tk./cattle)	Present value (Tk./cattle)	Market value increment (%)
Eman Ali	1	29	45	55	18700	31500	68
Rofiquel Islam	1	38	64	68	24300	35900	48
Raisul Islam	1	31	44	42	22000	36000	64
Golam mostofa	1	62	103	66	35000	58000	65
Pobitro kumar	1	30	46	53	19000	34500	81

11.3.8. Milking cow rearing in farmers house hold at FSRD Site: Jamla, Patuakhali

At the FSRD Site two farmers engaged in milking cow rearing and most of them have indigenous breed with average milk yield per lactation increased about 353 liter which was below 300 liters before intervention. Milk production increased due to better veterinary services, deworming and feed management, especially supply of green fodder during dry season. Seeds of Napier grass were supplied to the farmers during February-July 2020. From total produced milk farmers consumed (170 liter) and sold (133 liters). Income from milk sold per farm family was Tk. 6650 (Table 11.64).

Table 11.64. Milk production and income from milking cow rearing at FSRD Site, Jamla, Patuakhali during April 2020 – January 2021

Name of Farmers	Cows (No.)	Before inter vention milk production / Cow (liter)	After intervention milk production/cow (liter))			
			Total	Consume	Sold	Income (Tk.)
Anwar Hossain Mrida	01	325	360	160	100	5000
Kabir Hossain	01	275	346	180	166	8300
Average		300	353	170	133	6650

Price of milk/liter Tk.50



Picture 11.29. Milking cow rearing and fodder production at FSRD site, Jamla, Patuakhali

11.3.9 Goat rearing in farmer's household at FSRD Site: Kaliganj, Satkhira (BRR)

During 2018-2021, thirty-three kids were born from the distributed goats among the 19 farmers. The goats needed very low maintenance and after reaching maturity, each doe (female goats) gave birth twice each year. The newly born goat kids in 2021 were healthy. The project authorities has been purchased two female goat kids from two cooperator farmers and were distributed among two other cooperative farmers (each farmer got one kid) under this program. Total return farmer-1 year-1 during 1st, 2nd and 3rd year were Tk. 7000, Tk. 10714 and Tk. 7857, respectively. Gross margin farmer1 year1 during 1st, 2nd and 3rd year were Tk. 4720, Tk. 8114 and Tk. 5407, respectively (Table 11.65). Goats produced little amount of milk which was sufficient for the kids of the farm family but not sufficient for sale in the market. The goats were given to the female cooperative farmers at the FSRD site. The farmers were happy with production of goat kids. When the kids mature, they were sold in the market thus improve the family solvency as well as make economic freedom of the female farmers. As the Black Bengal Goat needs very little maintenance cost and farmers were pleased with their returns.

Table 11.65 Production of goat kid from she goat rearing at FSRD Site, Kaliganj, Satkhira during February 2018 –2021

Description of Item	Year I	Year II	Year II
Number of farmers	5	7	

Description of Item	Year I	Year II	Year II
Number of goats supplied per farmers	2	2	
Date of supply	7.6.2018	17.6.2019 and 14.1.2020	-
Age of goat during distribution (month)	7-10	5-6	-
Initial body wt./goat (Kg)	7.87	8.8	-
Procurement price/goat (Tk.)	3800	*	-
No of goat survived	10	14	14
Weight gained/goat (Kg) after six months	16.07	17.5	15.6
Total number of kids born (Feb.2018-Dec. 2020) per farmer	7	15	11
Total return (Tk.) per farmer (value of product and by product, consumption and distribution)	7000	10714	7857
Total variable cost (Tk.) per farmer	2280	2600	2450
Gross margin (Tk.)/farmer	4720	8114	5407
Gross margin (Tk.)/ farmers	23600	56800	37850

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

*= Female kids collected from other farmers



Picture 11.30. Goat rearing at FSRD Site, Kaliganj, Satkhira during 2018-20

11.3.10. Vaccination of poultry birds against major diseases to reduce mortality (%) at FSRD Site: Subarnachar, Noakhali (BARI)

Different types of Vaccination were done for controlling diseases of Chicken, duck and pigeon as per schedule suggested by respected personnel of DLS (Table 11.66). Seven types of vaccine like, BCRDV, RDV, Fowl Pox, Fowl Cholera, Duck plague, Duck Cholera and Pigeon Pox were vaccinated on poultry birds. A total of 2895, 1267 and 342, chicken, duck and pigeon were vaccinated against major diseases respectively, during February 2018- January 2021. After vaccination of poultry bird, all of the disease frequency reduced drastically. It was observed that before vaccination mortality rate of poultry birds due to different diseases was higher 6.58-23.38% (Avg.15.66%). After vaccination all of the diseases reduced drastically 1.90- 2.96% (Avg.2.21).

Table 11.66. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD Site, Subarnachar, Noakhali during 2018-2021

Year of vaccination	Name of the vaccine	No. of birds			Mortality (%)	
		Chicken	Duck	Pigeon	Before vaccination	After vaccination
Year I	BCRDV	55	-	-	19.58	2.10
	RDV	287	-	-		
	Fowl Pox	232	-	-	15.39	1.96
	Duck plague	-	183	-		
	Pigeon Pox	-	-	69	6.58	2.96
Year II	BCRDV	111	-	-	23.38	1.90
	RDV	210	-	-		
	Fowl Pox	185	-	-		
	Fowl Cholera	193	-	-	18.48	1.90
	Duck plague	-	280	-		
	Duck Cholera	-	237	-	7.69	2.15
	Pigeon Pox	-	-	103		
Year III	BCRDV	155	-	-	23.38	2.43
	RDV	530	-	-		
	Fowl Pox	480	-	-		
	Fowl Cholera	457	-	-	18.48	2.11
	Duck plague	-	264	-		
	Duck Cholera	-	312	-	7.69	2.40
	Pigeon Pox	-	-	170		
Total		2895	1267	342	Avg.15.66	Avg.2.21

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

11.3.11. Vaccination program on poultry birds at FSRD Site: Jamla, Patuakhali (BARI)

This program was conducted at FSRD site, Jamla, Dumki, Patuakhali during 2018-2021. Four types of vaccines (BCRDV, RDV, Fowl Pox and Duck plague) were vaccinated on poultry birds (Table 11.67). Results revealed that, mortality rate can be minimized significantly through vaccination and it goes down below 5% most of the cases in the sites. By the vaccination of BCRDV, RDV, Fowl Pox and Duck plague mortality rate was reduced 93%, 91%, 87% and 90% respectively. After vaccination of poultry, all of the diseases frequency reduced drastically and mortality rate came down 8% (Table 11.67). The vaccination of poultry program has created a great awareness to the co-operative farmers and neighborhood farm families of the site and this type of program is mostly impacted on concern farmer and so far they would follow to vaccinate the poultry in routinely.



Picture 11.31. Poultry vaccination at FSRD Site: Jamla, Patuakhali

Table 11.67. Number of birds vaccinated and mortality rate before and after vaccination at FSRD site, Jamla, Dumki, Patuakhali during 2018-2021

Name of poultry	Name of vaccine	No. of bird vaccinated	Mortality before Vaccination (%)*	Mortality after Vaccination (%)*	Mortality reduces (%)
Chicken	BCRDV	85	60	4	93
	RDV	100	80	7	91
	Fowl Pox	150	45	6	87
Duck	Duck plague	180	80	8	90

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

11.3.12. Vaccination program on poultry birds at FSRD Site: Kaliganj, Satkhira (BRR)

Distributed poultry birds were vaccinated within a few days of dispersal. BCRDV and RDV vaccination was done on 250 mature Turkeys and its chick. RDV vaccination was done on 195 Sonali chickens. DPV vaccination was done on 284 Khaki Campbell ducks (Table 11.68). It was observed that before vaccination mortality rate of poultry birds due to different diseases ranged from 22 - 34% (Avg. 28.9%). After vaccination all of the diseases reduced drastically ranged from 2.0–7.0% (Avg. 3.6). Before intervention, at the FSRD site, Kaliganj, Satkhira, farmers were reluctant to vaccinate their poultry bird's viz. distance from the Upazilla Livestock Office to the site, handling and storage problems of vaccines, absence of any vaccine applying person in the location. After intervention, two farmers were trained up as LSP for applying vaccine to the poultry birds.

Table 11.68. Vaccination program of distributed poultry birds at FSRD site, Kaliganj, Satkhira during Feb 18-Dec 20

Year of vaccination	Name of the vaccine	No. of poultry birds Vaccinated			Mortality (%)	
		Chicken	Duck	Turkey	Before vaccination	After vaccination
Year I	BCRDV			78	34	4
	RDV	52		78	30	5
	DPV		46		22	7
Year II	BCRDV			47	34	3
	RDV	68		47	30	3
	DPV		38		22	5
Year III	BCRDV				34	3
	RDV	75			30	2
	DPV		200		22	3
Total		195	284	250	Avg.28.9	Avg.3.6

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



Picture 11.32. PoultryVaccination program at FSRD Site Kaliganj, Satkhira

11.3.13. Vaccination program on poultry birds at FSRD Site: Shyamnagar, Satkhira (BINA)

A total number of 1338 of poultry birds were vaccinated in the project area during February 2019-December 2020. Among them chicken, duck, perigon and Turkey were 605, 279, 90 and 264 respectively (Table 11.69). The poultry birds were vaccinated with RDV, BCRDV, Fowl Pox, and Fowl Cholera against major diseases. It was observed that before vaccination, mortality rate of poultry birds due to different diseases was as high as 20-30% (Avg.25.33). After vaccination all the diseases reduced drastically and mortality was recorded 5-12% (Avg. 8.33). Farmers were interested to continue vaccination of chicken, duck, pigeon and turkey due to reduction of mortality.

Table 11.69. Mortality (%) of poultry birds before and after vaccination against major diseases at FSRD Site Shyamnagar, Satkhira during 2018- 2021

Year	Name of the vaccine	No. of poultry birds Vaccinated				Percentage of mortality (%)	
		Chicken	Duck	Pigeon	Turkey	Before vaccination	After vaccination
Year I	Fowl Pox, and Fowl cholera				65	26	5
Year II	RDV, BCRDV, Fowl Pox, and Fowl Cholera	293	132	55	113	30	12
Year III	RDV, BCRDV, Fowl Pox, Cholera vaccine	312	147	135	86	20	8
Total		605	279	190	264	Avg.25.33	Avg.8.33

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

11.3.14. Poultry rearing at farmer's household at FSRD Site: Jamla, Patuakhali (BARI)

Almost every participatory household family in the site use to rear small flocks of indigenous domestic fowl and ducks under a backyard management system although indigenous poultry are poor producers of eggs and meat. There has no systematic breeding program and close inbreeding occurs among indigenous stocks. Moreover, to meet the increasing demand of meat new and non-traditional poultry were distributed among the farmers



Picture 11.33. Poultry rearing at FSRD Site Jamla, Patuakhali

of FSRD site Jamla, Dumki, Patuakhali. Systematic rearing system such as feed management, housing management, egg hatching mud pot and vaccination program for poultry birds were done according to plan of activities in the site. The average initial body weight of sonali chicks was 62-72g during distribution. Final body weight was 1.78 kg, 1.85 kg and 1.98 kg in three consecutive years. Body weight increased after six months was 1.72 kg, 1.79 kg and 1.91kg respectively. Average total return farmers⁻¹ year⁻¹ were 14027, 22252 and Tk. 20873 respectively. Average gross margin per farmers⁻¹ year⁻¹ during 1st, 2nd 3rd and were 7877, 13452 and Tk. 11253, respectively (Table 11.70).

Table 11.70. Average performances of Sonali chicken for meet purpose at farmers' level after 6 months of rearing at FSRD site Jamla, Dumki, Patuakhali during 2018- 2021

Description of Item	Year I	Year II	Year III
Number of farmers	12	12	12
No of birds supplied per farmers	10	10	10
Initial body wt/bird (g)	62	64	72
Procurement price/bird (Tk.)	20	22	20
No of chicken survive/farmer	9	9	8
Weight gained/bird (Kg) after 6 month	1.78	1.85	1.98
Egg Production (Number)	247	342	363
Consumption	24	48	56
Sale	103	94	125
Distribution	0	0	0
Hatch	108	190	172
Damage	12	10	10
Total income from chick rearing (Tk.)	14027	22252	20873
Total variable cost (Tk.)	6150	8800	9620
Gross margin (Tk.)	7877	13452	11253

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



Picture 11.34. Sonali Chicken rearing at FSRD Site, Jamla, Patuakhali

11.3.15. Performance of Sonali Chicken (layer) under semi scavenging system at FSRD Site: Kaliganj, Satkhira (BRR)

During baseline survey, each farm family had an average of 5.75 local hens in their homestead. After intervention, on an average each farmer was supplied with 16 Sonali chickens. Egg production data were collected from February 2018 until January, 2021 (Table 11.71). Total number of eggs produced from four farmers' chickens (44) during 1st year was 2936 which increased to 6392 eggs from eight farmer's chicken (96) in 2nd year and 12727 eggs from fifteen farmers' chickens (165) in 3rd year. From three years results it was observed that average egg consumption was 183 farmers⁻¹ year⁻¹. Distribution of egg was recorded as 17 and selling of egg farmers⁻¹ year⁻¹ was 5238. Increased production of eggs encouraged the farm families to distribute relatively more eggs to their relatives and neighbor. Body weight gained per bird during 1st, 2nd and 3rd year were 2.15 Kg, 2.18 Kg and 2.25 Kg, respectively. Average total return family⁻¹ year⁻¹ during 1st, 2nd and 3rd year were Tk. 6472, Tk. 6992 and Tk. 7228, respectively. Average gross margin farmers⁻¹ year⁻¹ in 1st, 2nd and 3rd year were Tk. 3622, Tk. 5057 and Tk. 5403, respectively. Improved chicken rearing under semi-scavenging feeding with proper management condition created a positive impact among the farmers. In the 1st year, the average egg consumption was 101 eggs farm family⁻¹, which increased to 195 and 200 eggs farm farmers⁻¹ in the following years of intervention. The turkey farmers were switched over to Sonali chicken farming. They are giving positive opinions about Sonali chicken farming. The chickens were matured and increasing egg production day by day.

Table 11.71. Average production performance and egg disposal pattern per farmer of Sonali chicken (layer) rearing at FSRD site, Kaliganj, Satkhira during 2018-21

Description of Item	Year I	Year II	Year III
Number of farmers	4	8	15
No of birds supplied	20	15	15
Date of supplied period	6.6.2018	4.8.2019	28.07.2020
Initial body wt. bird ⁻¹ (g)	260-275	260-275	260-275
Procurement price bird ⁻¹ (Tk.)	130	130	130
No of chicken survive	44	96	165
Date of delivery egg	October, 2018	November, 2019	November, 2019
Egg Production (no.) per farm family			
Consumption	404	1560	3003
Sale	2372	4432	8910
Distribution	152	432	814
Total number of Egg	2936	6392	12727
Performance of Bird			
Weight gained/bird (Kg)	2.15 kg	2.18 kg	2.25 kg
Consumption	6	11	14
Sale	2	5	8
Distribution	0	0	0
Total number	8	16	22
Total gross return from bird (Tk.)	2400	4800	6600

Description of Item	Year I	Year II	Year III
Total variable cost (Tk.)	2850	1935	1825
Total return/farmer in Tk. (Market value of Egg + Meat)	6472	6992	7228
Gross margin/farmer (Tk.)	3622	5057	5403

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

*Egg price (Tk/pc.) = 8, Meat price (Tk/Kg) = 170



Picture 11.35. Sonali chicken rearing at FSRD Site, Kaliganj, Satkhira during 2018-20

11.3.16. Rearing of Sonali chicken in farmers' house at FSRD Site: Shyamnagar, Satkhira (BINA)

Average performances of Sonali chicken for meet purpose at farmers' homestead after 6 months of rearing are presented in Table 11.72. The average initial body weight of sonali chicks was 60-70g during distribution. Number of chicken survive farmers⁻¹ were 18, 28 and 37 in three consecutive years. Body weight increased after six months were 1.14 kg, 1.25 kg and 1.32 kg. during 1st, 2nd and 3rd year, respectively. Average total return farmers⁻¹ were 4200, 6100 and Tk. 8400 in three consecutive years respectively. Average gross margin farmers⁻¹ in the 1st, 2nd and 3rd year, were 49300, 56700 and Tk.67500, respectively (Table 11.72).

Table 11.72. Average performances of Sonali chicken for meet purpose at farmers' homestead after 6 months of rearing at FSRD site Shyamnagar, Satkhira during February 2018-January 2021

Description of Item	Year I	Year II	Year III
Number of farmers	12	12	12
No of birds supplied per farmers	20	30	40
Date of supplied period	03-10-2018	14-07-2019	25-06-2020
Initial body wt./bird (g)	60-70	60-70	60-70
Procurement price/bird (Tk.)	18	20	20
No of chicken survive/farmer	18	28	37
Weight gained/bird (Kg.) after 6month	1.14	1.25	1.32
Consumption	32	70	85
Sale	186	264	370
Distribution	0	0	0
Total number	218	334	445
Total gross return from bird (Tk.)	67600	82300	101500

Description of Item	Year I	Year II	Year III
Total variable cost (Tk.)	18300	25600	34000
Total return/farmer in Tk. (Market value of Egg + Meat)	4200	6100	8400
Gross margin (Tk.)	49300	56700	67500

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

11.3.17. Performance of Khaki Campbell duck in farm household at FSRD Site: Kaliganj, Satkhira (BRR)

Data related to Khaki Campbell breed at farmers level is presented in Table 11.73. Average number of eggs laid per month during Feb. 2018 – Jan. 2021 for each farmer was 115 with the highest number of eggs was 168 and the lowest number was 54 (Table 11.73). The average egg consumption/month increased from before interventions of 31 eggs to 68 eggs farmers-1. After intervention, monthly total income per farmer was Tk. 921 and gross margin was Tk. 683. The ducks were matured and increasing egg production day by day. Farmers used the money that comes from egg selling in different purpose such as buying daily necessary needs, educational purpose of children. Farmers showed their keen interest for rearing of Khaki Campbell for both egg and meet purpose. They opined that, they had a little or no knowledge about modern disease and feed management technology. Hence more motivation and awareness build up programs should be taken for greater extension of the technology. Farmers especially women and children expressed their satisfaction to duck rearing by improved rearing system and commercially profitable breeds.

Table 11.73. Production performance of Khaki Campbell duck and egg disposal pattern at FSRD site, Kaliganj, Satkhira during Feb. 2018 - Jan. 2021

Name of Farmer	Survived ducks (no.)	Body wt. after six months (kg)	Egg production/month	Egg Consumption/ month		Monthly total income (Tk.)	Expenditure/month (Tk.)	GM /month (Tk.)
				Before rearing	After rearing			
Sajeda Khatun	12	1.4	144	30	78	1152	244	908
Jahanara	13	1.5	168	36	85	1344	257	1087
Halima Khatun	13	1.2	125	28	72	1000	220	780
Asma Khatun	12	1.5	159	37	88	1272	264	1008
Salma Parvin*	14	1.5	76	28	54	608	235	373
Murshida*	13	1.3	54	25	42	432	215	217
Bina Khatun*	11	1.2	80	31	58	640	230	410
Average	12	1.38	115	31	68	921	238	683

*New farmers, Egg price=8 Tk/pc, Initial duck weight=180-200g, GM = Gross margin



Picture 11.36. Khaki Campbell duck rearing at FSRD Site Kaliganj, Shatkhira

11.3.18. Turkey rearing in household condition by cooperative farmers at FSRD Site: Kaliganj, Satkhira (BRR)

Performances of Turkey rearing after 12 months at farmers' level are presented in Table 11.74. A total number of 349 eggs were laid by Turkeys (38) during February 2018-January 2019. From which farmers sold 275 eggs in the local market consumed 26 eggs. Women farmers hatched Turkey eggs using the local hens in conventional method and sold the turkey chicks to other farmers. Average net return (Tk. 12157) was obtained from matured turkey, turkey chicks and selling eggs. Three live Turkeys were consumed by three different farmers. Average gross margin was calculated Tk. 6017 farmers⁻¹ year⁻¹. A total number of 854 egg laid by Turkeys (23) during February 2019-January 2020 of which farmers sold 553 eggs in the local market and consumed 58 eggs. Average net return of Tk. 9910 was earned from matured turkey, chicks and selling eggs. Seven live turkeys were consumed by five different farmers. Average gross margin was calculated Tk. 7278 farmers⁻¹ year⁻¹. A total number of 389 egg laid by Turkeys (14). during February 2020 -January 2021. From which farmers sold 331 eggs in the local market and consumed 58 eggs. Average net return (Tk. 3399) was obtained from matured turkey, hatched turkey chicks and selling eggs. Four live Turkeys were consumed by three different farmers. Average gross margin was calculated Tk. 2785 farmers⁻¹ year⁻¹.

After intervention, farmers were highly satisfied with the new poultry birds for more egg and meat production, good price and additional monthly income. Turkey rearing gradually gained popularity in the project area. Due to more people were involved in Turkey rearing, the price of Turkey eggs, mature Turkeys and Turkey chickens decreased gradually. All of the farmers completely sold out their mature Turkeys and chicks. There were some reasons behind their loss of interest:

- As of more people got involved in Turkey rearing, the price of egg, meet & chicks decreased
- Most of the people at FSRD site were financially poor resulting in less interest in buying mature Turkeys
- Turkeys take long time to get marketable size
- The taste of Turkey meats doesn't vary too much from chicken meat, so the people are not interested of buying 7-8 kg Turkeys rather than buy 1-2 kg chickens

Table 11.74. Average performances of Turkey rearing after 12 months at farmers' level during 2018-21 at FSRD Site, Kaliganj, Satkhira

Description of Item	Year I	Year II	Year III
Number of farmers	5	5	3
No of birds supplied	50	50	30
Date of distribution	2.6.2018	2.6.2019	2.6.2020
Initial body wt./bird (kg)	0.175	0.190	0.200
Procurement price/bird (Tk.)	230	230	230
No of chick survive	38	23	14
Date of delivery egg	November, 2018	November, 2018	November, 2018
Egg Production (Number)			
Consumption	26	58	40
Sale	275	553	264
Distribution	48	243	27
Total number of Egg	349	854	331
Performance of Bird			
Weight gained/bird (Kg)	5.85	9.13	7.50
Consumption	3	7	4
Sale*	21	77	5
Distribution	0	0	0
Total number	38	84	9

Description of Item	Year I	Year II	Year III
Total income from bird (Tk.)	50015	36740	10198
Total variable cost (Tk)/farmer	6140	2632	614
Total return/farmer in Tk. (Market value of Egg + Meat)	12157	9910	3399
Gross margin (Tk.)	6017	7278	2785

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

*chick and mature turkey; Turkey egg price (Tk./pc) = 15-50, Meat price (Tk./kg) = 180-300



Picture 11.37. Turkey rearing at FSRD Site Kaliganj, Satkhira

11.3.19. Turkey rearing under scavenging system in farmers house at FSRD Site: Shyamnagar, Satkhira (BINA)

Performances of Turkey rearing in farmers' household after six months are presented in Table 11.75. The average initial weight of a single chicken was 85g. Number of chicken survive farmer⁻¹ were 50, 65 and 34 in three consecutive years, respectively. Number of egg production 1330, 1200 and 840 during 1st, 2nd and 3rd year, respectively. The egg consumption rate was increased among family members as well as nutritional intake was also increased. Farmers sold and hatched egg on an average 35% and 45%, respectively. About 15% eggs were damaged during hatching. Average body weight gained bird⁻¹ was 7.0 kg after six-month of rearing. By hatching eggs chicks were born and newly borne chick 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. Total numbers of alive Turkey were found 125,210 and 90 during 1st, 2nd and 3rd year, respectively. Gross margin from turkey rearing farm family⁻¹ were 269650, 350545 and Tk. 141550 during 1st, 2nd and 3rd year, respectively. 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 11.75 Average performances of Turkey in farmers' house after six months of rearing at FSRD Site Shyamnagar, Satkhira during 2018- 2021

Description of Item	Year I	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 (g)	80-90	75-90	80-90
Procurement price/bird (Tk.)	370	350	300
No of chick survive	50	65	34
Date of delivery egg	27-09-2018	27-06-2019	20-07-2020

Description of Item	Year I	Year II	Year III
Number of farmers	1	7	1
Egg Production (Number)			
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 ⁻¹ (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
Total variable cost (Tk.)	92000	119600	75000
Total return/farmer in Tk. (Market value of Egg+Meat)	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

11.3.20. In house pigeon rearing in farmer's household at FSRD Site: Subarnachar, Noakhali

Performance of in-house pigeons rearing in farmers household are presented in Table 11.76. One marginal farmer started pigeon rearing in house with initial stock six pair. The present stock of the pigeon is 27 pair during February 2020- January 2021. Average squab production was 8 pair month⁻¹. They sold 75% and consumed 25% which increase their income and nutrition uptake. Pigeon rearing is profitable and it provides additional income of Tk. 1500 farmer⁻¹ by squab production. The value of present stock is Tk.16200. Besides in house pigeon rearing, almost every household are being practicing pigeon rearing and the average flock size was 4 pair.

Table 11.76. Performance of in-house pigeons rearing in farmers' household at FSRD site Subarnachar, Noakhali during February 2020- January 2021

Initial stock (pair)	Present stock (pair)	Squab production (pair month ⁻¹)	Consumption (pair month ⁻¹)	Distribution (pair month ⁻¹)	Value of present stock (Tk.)	Selling (TK. month ⁻¹)
06 pair	27	8	2	1	16200	1500

*One pair squab price = 250/-



Picture 11.38. Pigeon rearing at FSRD Site, Subarnachar, Noakhali

11.3.21. Small scale pigeon rearing in farmer's household at FSRD Site Jamla, Patuakhali

Income from in house pigeon rearing are presented in Table 11.77. The activity was undertaken at the FSRD site Jamla, Dumki, Patuakhali during 2020. Twenty-four pairs of adult pigeon were distributed among 12 farmers (Two pairs to each farmer) during February to June 2020. Average per farm squab production was 08 pair during February to June 2020. In four month squab production was 8 pair per farm of which 3 pair was stocked. Per farm squab consumption was 2 pair and sold 3 pair during 4 months. Squab stocking as well as selling increased their income. Consumption of squab also increased their nutrition. Pigeon rearing provides additional income of Tk. 3600 farm⁻¹ by squab stocking and selling.



Picture 11.39. Pigeon rearing at FSRD Site, Jamla, Patuakhali

Table 11.77. Average per farm income from in house pigeon rearing at FSRD Site, Jamla, Patuakhali during February 2020 to January 2021

Initial stock (pair)	Present stock (pair)	Squab consumption (pair)	Squab distribution (pair)	Squab sell (pair)	Value of present stock (Tk.)	Income from selling (Tk.)
02	05	02	0	03	3000	600

*One pair squab price = 200/-

Key words: Pigeon, squab, nutrition, income, production

11.3 .22. Small scale pigeon rearing in farmer's household at FSRD Site: Shyamnagar, Satkhira

Performance from supplied pigeons to different farmers' household are presented in Table 11.78. Average body weight gain per pigeon was 735g. Average squab production was 17 per household during December 2019- January 2021. Farmers sold the squab 60% and consumed 20% which increase their income and nutrition uptake. Pigeon rearing was profitable and it provides additional income of Tk. 2167 farmers⁻¹ by squab production.

Table 11.78. Performance of supplied pigeons at FSRD site Shyamnagar, Satkhira during December 2019-January 2021

Farmer	Pigeon no.Family ⁻¹	Average weight (g)	No. of Squab born	Pigeon died	Squab Intake	Sell	Income (Tk.)
Abdul Khalek	4	730	20	1	5	9	2500
Ujjal hosen	4	700	12	2	3	6	1500
Golam Mostofa	4	750	14	0	2	6	1750
Pobitro kumar	4	755	18	1	3	7	2250
Wasim kumar	4	690	12	1	3	8	1500
Debobroto	4	800	28	0	4	8	3500
Average	4	Avg.735	104 Avg.17	5	20	34	2167

Squab price: Tk. 200-250/pair

11.3.23. Napier grass as a fodder crop cultivation at FSRD Site: Subarnachar, Noakhali

Fodder contains a major protein of daily ration of milch cow and therefore, cultivation of nutritious and high yielding variety fodder is inevitable. In the project dimension, Napier grass as a fodder was cultivated and harvested of green fodders was done according to the nature of the fodder crops. Green fodder of Napier grass was collected three times and yield was highest during second time harvesting (7.10- 8.13t ha⁻¹) lowest (4.76 - 5.29 t ha⁻¹) during first time harvest (Table 11.79).

Table 11.79. Production of Napier grass at FSRD Site, Subarnachar, Noakhali during 2018-2021

No. of Farmers	Average area	Date of cutting planting	Green Fodder harvesting(DAS)	Fodder yield (t ha ⁻¹)
6	2 dec.	25 to 28 October,2018	32-35	5.29
			65-67	8.13
			95-98	7.72
		22 to 25 April 2019	32-35	5.09
			65-67	7.10
			95-98	6.89
		15 to 20 October, 2019	30-32	4.76
			63-65	7.56
			92-98	7.01
		25 Nov. 2020 to 07 Jan., 2021		30-32



Picture 11.40. Fodder production, feeding and body weight measurement of the cattle at FSRD site, Subarnachar, Noakhali

11.3.24. Small-scale Vermicompost production in homestead at FSRD Site: Subarnachar, Noakhali (BARI)

Initially, one hundred forty to forty-eight kilograms of partially decomposed cowdung were used in the ring to produce Vermicompost. For producing first time Vermicompost, the *Eisenia fetida* earthworms took 65 to 72 days. Time differences for first Vermicompost collection was observed due to each farmer's conditions, management, and number of alive earthworms after release. However, as the earthworms multiply overtime, the production time of Vermicompost became decrease. As a result, duration required for the 2nd, 3rd and 4th cycle were (37-41 days), (28-34 days) and (25-27 days), respectively (Table 11.80). The highest production was found from the first-time collection (47kg ring⁻¹) and the lowest (40 kg/ring) from the third time collection. Before collecting Vermicompost, the materials were sieved for collecting earthworms and eggs of the worms for the next cycle. Average production from each ring was 43.25 kg. Most of the farmers used Vermicompost for vegetables production and two farmers used it for watermelon production.

Table 11.80. Average Production cycle of Vermicompost at FSRD site, Subarnachar Noakhali

Vermicompost collection (days)	Production (kg per ring)
First collection 65 to 72	47
Second collection (37 to 41)	44
Third collection (28 to 34)	40
Fourth collection (25 to 27)	42
Total	173 (Avg. 43.25)



Picture 11.41. Vermicompost production and utilization at FSRD site, Subarnachar, Noakhali

11.4. Fisheries Component

11.4.1. Maximization of farmer's income through carp polyculture technique at low cost management in perennial pond at FSRD Site: Patuakhali and Noakhali (BARI)

In Patuakhali pond size varied from 4 dec. to 15 dec. and average depth varied from 1.12 m to 1.4 m. Stocking density were 36 to 38 fingerlings for one decimal pond area. Whereas in Noakhali, pond size varied from 9.78 dec. to 30 dec., average depth was from 1.3m to 1.9 m. Survival rate of fingerlings ranged from 72- 80 % in Patuakhali and 85 - 95% in Noakhali FSRD Site (Table 11.81)

Table 11.81 Performance of carp polyculture in pond at the FSRD Sites Patuakhali and Noakhali after 12 months culture

Location	Farmer's category (No.)	Avg. area (dec.) & Avg. depth of pond (m)	No. of fingerlings per dec.	Average individual weight of fingerlings (g)	Average Production (kg) and No. of fishes per dec.	Survival rate (%)
Patuakhali	Marginal	15 dec. & 1.4 m	37	35	12.07 (27)	73
	Small	4 dec. & 1.12 m	36	30	14.75 (26)	72
	Medium	12 dec. & 1.35 m	38	34	30.0 (30)	80
Noakhali	Marginal	9.78 dec. & 1.37 m	35	34	31.49 (30)	85
	Small	19 dec. & 1.8 m	35	34	48.0 (33)	95
	Medium	30 dec. & 1.9 m	35	34	48.0 (33)	95

In the three culture period, highest productions were found 1080 kg 0.04 ha⁻¹ and 4320 kg 0.12ha⁻¹ at Noakhali and Patuakhali, respectively, from medium farmers. Among the total production, major part of production farmers was consumed whereas a modest amount of their production sold and distributed. The highest consumption (650 kg and 2635 kg) and highest sold (380 kg and 1623kg) were observed in medium farmers of Noakhali and Patuakhali, respectively (Table 11.82).

Table 11.82. Total fish production, utilization pattern in both FSRD Sites Patuakhali and Noakhali during Feb. 2018- Jan. 2021

Location	Farmer's category (No.)	Total production (kg)	Consumption (Kg)	Distribution (Kg)	Sold (Kg)
Patuakhali	Marginal	543	543	-	-
	Small	177	177	-	-
	Medium	1080	650	-	380
Noakhali	Marginal	924	630	-	294
	Small	2736	2052	-	684
	Medium	4320	2635	62	1623

In the three culture period, highest gross return and gross margin were found Tk.1620000 and Tk. 88350 pond⁻¹ in the medium farmers at Patuakhali and BCR ranged from 1.20 to 1.39 (Table 11.83.). On the other hand, in Noakhali highest gross return and gross margin, Tk. 648000 and Tk. 280500 were found from the medium farmers and BCR ranged from 1.07 to 1.76 (Table 11.83).

Table 11.83. Production and economic analysis of fish culture at FSRD sites Patuakhali and Noakhali from Feb. 2018- Jan. 2021

Location	Category	Total production (kg)	Gross return (k.)	TVC (Tk.)	Gross margin (Tk.)	BCR
Patuakhali	Marginal	543	81450	34103	47347	1.39
	Small	177	26550	10252	16298	1.59
	Medium	1080	162000	73656	88350	1.20
Noakhali	Marginal	924	138600	87020	71680	1.07
	Small	2736	410400	254700	155700	1.61
	Medium	4320	648000	47500	280500	1.76

Farmers of both FSRD site were very impressed with the performance of carp polyculture. The neighbor farmers showed their keen interest to take the carppolyculture system in their ponds. Carp polyculture in the perennial pond is very promising for its higher yield as all ecological niches of pond are effectively utilized the plankton of different layer. So, farmers can be economically benefited by carppolyculture technique.

11.4.2. Maximization of farmer's income through monoculture technique of different fish species at FSRD Site: Noakhali and Patuakhali (BARI)

Average weight of fingerlings was 1.0 g with stocking density of 270 no. dec⁻¹. The fish species were mono sex tilapia, Sorputi and shing. At Patuakhali only mono sex tilapia was cultured in three categories of farmers ponds. On the other hand, at Noakhali, mono sex tilapia, and Sorputi + and shing were cultured in the ponds of marginal and medium farmers, respectively. Survival rate of fingerlings ranged from 70- 72 % in Patuakhali and 60 - 65% in Noakhali FSRD Site. The highest average production was found 31 kg per dec. in medium farmer at Patuakhali. On the other hand, the average highest production (21.75 kg dec⁻¹.) was found from marginal farmers of Noakhali (Table 11.84).

Table 11.84. Performance of carp polyculture per pond in both FSRD site Patuakhali and Noakhali during Feb. 2018 - Jan. 2021

Location	Farmers category (No.)	Avg. area (dec.) & Avg. depth (m)	Average Initial wt. and number of fingerlings (Kg & No.)	Avg. weight of fingerlings (g)	Production Pond ⁻¹ (Kg & No.)	Production per dec. (Kg)	Survival rate (%)
Patuakhali	Marginal	7 dec. & 0.8 m	1.88 & 1880	1.0	197 (1316)	28.14	70
	Small	7 dec. & 0.8 m	1.88 & 1880	1.0	190 (1316)	27.14	70
	Medium	12 dec. & 1.2	3.23 & 3230	1.0	372 (2326)	31.00	72
Noakhali	Marginal	12 dec. & 1.5 m	3.0 kg (3000)	1.0	261 (1800)	21.75	60
	Medium	28 dec. & 2.0 m	8.40 kg (8400)	1.0	273 (5460)	9.75	65

Among the total production, major portion were consumed by farmers. A little amount of their production sold. The highest consumption and sold was shown in medium farmers in both the FSRD Site (Table 11.85).

Table 11.85. Fish production, utilization pattern in both FSRD site Patuakhali and Noakhali during Feb. 2018- Jan. 2021

Location	Farmer's category (No.)	Total production (kg)	Consumption (kg)	Sold (kg)
Patuakhali	Marginal	197	140	57
	Small	190	160	30
	Medium	372	272	100
Noakhali	Marginal	261	210	51
	Medium	273	173	100

In Patuakhali, the highest gross return and gross margin Tk. 40,920 and Tk.18,620 pond⁻¹, respectively were found in medium farmer and BCR ranged from 1.87 to 1.93. On the other hand, the average highest gross return and gross margin Tk. 49140 and Tk. 22640 were found from medium farmers of Noakhali and BCR ranged 1.74 to 1.85 (Table 11.86).



11.42. Fish culture at FSRD sites Noakhali and Patuakhali

Table 11.86. Average total production and cost return analysis of fish culture per household in both FSRD site Patuakhali and Noakhali from Feb. 2019- Jan. 2021.

Location	Category	Average total production (Kg)	Gross return (Tk.)	TVC (Tk.)	Gross margin (Tk.)	BCR
Patuakhali	Marginal	197	21670	11200	10470	1.93
	Small	190	20900	11200	9700	1.87
	Medium	372	40920	22300	18620	1.84
Noakhali	Marginal	261	36540	21000	15540	1.74
	Medium	273	49140	26500	22640	1.85

In 2019 Ampan and Covid-19 affected in both FSRD site, for this reason

* Fries collection became delayed.

* Price of fries became high.

Farmers of both FSRD site were very impressed with the performance of monoculture of monosex tilapia (Hussain, 2009). The neighbor farmer showed their keen interest to adopt the culture system in their ponds. Monosex tilapia culture in both seasonal and perennial ponds is very promising for its higher production and effectively utilized utilization of the plankton of different layer.

11.4.3. Fish polyculture in saline Gher system at FSRD Site: Kaliganj, Satkhira (BRRI)

Fish production performance in gher polyculture is shown in Table 11.87. All of the farmers harvested their Ghers in January. Average Gher area was 145 decimals for five farmers. Average survival rate was found 73.2%. Average initial weight of fingerlings and weight of fish (after 6 month of culture) were recorded 71.6 g and 811 g, respectively. Average fish weight gained 1032% over initial weight after six months of rearing. Ahmed and Alam (1989) also reported similar results in ponds.

Table 11.87. Average Performance of Gher polyculture fish farming at FSRD site Kaliganj, Satkhira during 2018-21

Sl No.	Area & depth of pond (dec & m)	Amount and number of fries	Av. weight of fingerlings (g)*	Final average weight of fish (g)*	Total amount & number of fish	Survival rate (%)
1.	180 dec 1.6 m	13320	78	876	9590	72
2.	165 dec 1.3 m	10395	71	822	8108	78
3.	170 dec 1.6 m	11050	66	789	8288	75
4.	130 dec 1.6 m	8580	70	753	6263	73
5.	80 dec 1.3 m	6760	73	813	4597	68
Avg.	145 dec 1.5 m	10021	71.6	810.6	7369	73.2

*Excluding shrimp PL; shrimp initial wt.=0.005 g, shrimp final wt.=18-25 g

Total fish production, utilization pattern and income before and after intervention are presented in Table 11.88. Before intervention, the average fish production from Ghers were 3934 Kg/ha. Average gross return was Tk. 590,061 ha⁻¹ and gross margin was Tk. 277,304 ha⁻¹ with BCR of 1.89. During 2018-19, the average fish production from these Ghers were 5284 Kg/ha. Average gross return was Tk. 792,576 ha⁻¹ and gross margin was Tk. 439,316 ha⁻¹ with BCR of 2.24. During 2019-20, the average fish production from five Ghers were 6780 Kg/ha. Average gross return was Tk. 1016,945 ha⁻¹ and gross margin was Tk. 575,686 ha⁻¹ with BCR of 2.30. During Feb 20- Jan 2021, the average fish production from five Ghers were 7129 Kg/ha. Average gross return was Tk. 1069,394 ha⁻¹ and gross margin was Tk. 597,909 ha⁻¹ with BCR of 2.27. Usually, the Gher systems were used for Bagda production in Satkhira. This program was introduced of fish polyculture in Gher systems. Before intervention, farmers applied feed and fertilizers irregularly. After intervention, farmers were motivated to provide feed in their Ghers, apply timely

fertilizers and limes. The average BCR increased to 2.27, which was 1.89 before intervention. During 2018-2021, the production increased to 7.13 t/ha, which was 3.93 t/ha before intervention.



Picture 11.43 Fish polyculture in Gher at FSRD Site, Kaliganj, Satkhira

Table 11.88. Fish production, utilization pattern and income before and after intervention at FSRD site Kaliganj, Satkhira during 2018-21

Description	Before Intervention (kg/ha)	After Intervention (kg/ha)		
		February 2018- January 2019	February 2019-January 2020	February 2020 - January 2021*
Consumption	437	505	719	1020
Distribution	117	155	272	350
Selling	3380	4623	5789	5760
Total production	3934	5284	6780	7129
Gross return (Tk.)	590061	792576	1016945	1069394
Variable cost (Tk.)	312757	353260	441259	471485
Gross margin(Tk.)	277304	439316	575686	597909
BCR	1.89	2.24	2.30	2.27

*Partial harvest; Fish price (Tk./kg): Coral, Vangal, Faissa, Khorkhullu, Shrimp =300-400, Carp=120-150

11. 4 .4 Fish polyculture in mini pond system at FSRD Site: Kaliganj, Satkhira (BRR)

Fish production performance in mini pond polyculture shown in Table 11.89. Average pond area was 25.43 decimal for seven farmers. Average survival rate of different fishes were recorded 76%. Average initial weight of fingerlings and weight of fishes (after 6 month of culture) were recorded 98.31 g and 771 g, respectively. Average fish weight gained 784 % over initial weight after six months.

Table 11.89. Average yearly performance of fish polyculture at FSRD Site Kaliganj, Satkhira during 2018-21

SL No.	Area & depth of pond (dec. & m)	Amount and number of fingerlings (No.)	Avg. weight of fingerlings (g)	Final average weight of fish (g)	Total amount & number of fish (No.)	Survival rate (%)
1.	20 dec 1.7 m	560	111.5	854	465	83
2.	40 dec 2.3 m	1120	114.7	927	840	75
3.	15 dec 2.3 m	420	110.3	848	311	74
4.	18 dec 2.0 m	504	105.8	860	393	78
5.	25 dec 1.8 m	700	117.2	915	567	81
6.	30 dec 1.7 m	3900	63	511	2730	70
7.	30 dec 2.0 m	4140	65.7	483	2981	72
Avg.	25.4 dec 2.0 m	1621	98.31	771.14	1232	76

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

Total fish production, utilization pattern and income before and after Intervention are presented in Table 11.90. Before intervention, the average fish productions from seven ponds were 728 Kg ha⁻¹. Average gross return was Tk. 94,701 ha⁻¹ and gross margin was Tk. 44,194 ha⁻¹ and BCR was 1.88. During 2018-19, the average fish production from seven ponds were 971 Kg ha⁻¹. Average gross return was Tk. 126,268 ha⁻¹ and gross margin was Tk. 64,397 ha⁻¹ with BCR of 2.04. During 2019-20, the average fish production from seven ponds were 1496 Kg ha⁻¹. Average gross return was Tk. 194,453 ha⁻¹ and gross margin was Tk. 99,519 ha⁻¹ with BCR of 2.05. During Feb. 20- Jan. 2021, the average fish production from seven ponds were 2574 Kg ha⁻¹. Average gross return was Tk. 334,611 ha⁻¹ and gross margin was Tk. 173,755 ha⁻¹ with BCR of 2.08. Before intervention, the mini ponds were mainly used for household chores at the FSRD site. The program was initiated of fish polyculture in pond systems. The average BCR increased to 2.08, which was 1.88 before intervention. During Feb. 2018- Jan. 2021, the production increased to 2.574 t ha⁻¹, which was 0.728 t ha⁻¹ before intervention. The results are in agreement with the findings of Miah, *et al.*, (1993)

Table 11.90 Fish production, utilization pattern and income before and after intervention at FSRD site Kaliganj, Satkhira during 2018-21

Description	Before Intervention (kg/ha)	After Intervention (kg ha ⁻¹)		
		February 2018- January 2019	February 2019- January 2020	February 2020 - December 2020
Consumption	185	233	515	738
Distribution	78	97	175	233
Selling	466	641	806	1603
Total production	728	971	1496	2574
Gross return (Tk.)	94701	126268	194453	334611
Variable cost (Tk.)	50507	61871	94934	160856
Gross margin (Tk.)	44194	64397	99519	173755
BCR	1.88	2.04	2.05	2.08

*Fish price (Tk./kg): Carp fishes=120-150, Koi= 130-170, Shing= 250-300



Picture 11.44. Fish polyculture in mini pond at FSRD Site: Kaliganj, Satkhira

11.4.5. Maximization of farmer's income through carp polyculture technique at low cost management in perennial pond at FSRD Site: Shyamnagar, Satkhira (BINA)

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 (764.60 g) followed by silver carp, rohu and the lowest was found in shorputi (414.22g). Average survival rate of fish species was found 86.25% (Table 11.91).

Table 11.91. Performance of carp polyculture fish farming at FSRD site Shyamnagar, Satkhira during Feb. 2018- Jan. 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
Mrigal	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

Total fish production, utilization pattern and income before and after intervention are presented in Table 11.92. 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 (1350 kg ha⁻¹) was found during 1st year. The highest gross margin was found from 3rd year (Tk. 272522 ha⁻¹) and the lowest was observed in the 1st year (Tk.122000 ha⁻¹). Average Consumption increased 347%, distribution increased (100%) and sell were increased (487.47%).

Table 11.92. Fish production, utilization pattern and income before and after intervention at FSRD site Shyamnagar, Satkhira during Feb. 2018 - Jan. 2021

Description	Before intervention (kg/ha)	After intervention (kg ha ⁻¹)		
		Year I	Year II	Year III
Consumption	38	68	75	82
Distribution	0	5	4	13
Selling	375	1278	2447	2885

Description	Before intervention (kg/ha)	After intervention (kg ha ¹)		
		Year I	Year II	Year III
Total production	413	1350	2526	2980
Gross return (Tk.)	61950	202500	378825	446910
Total cost (Tk.)	37500	80500	155550	174388
Gross margin (Tk.)	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

11.5 Off-Farm Activities

11.5.1 Off farm activities at FSRD Site: Subarnachar, Noakhali (BARI)

Cost and return of off-farm activities at FSRD site, Noakhali are presented in Table 11.93. Weaving pati is a major off farm activities of woman farmers of Noakhali in their leisure period. Two to three persons can weave a pati (7ft x 5ft) within a month with decorative design. Depending on the quality average price of a Shital Pati Tk.11550. Due to intervention with decorative design and lucrative colour gross margin increased 235% over before intervention

Table 11.93 Cost and return of off-farm activities at FSRD site,Subarnachar, Noakhali

Before intervention			After intervention			GM increased (%)
GR (Tk.)	TC (Tk.)	GM (Tk.)	GR (Tk.)	TC (Tk.)	GM (Tk.)	
4200	1980	2220	11550	4120	7430	235

Note: GR = gross return; TC = total cost; GM = gross margin



Picture 11.45. Schumannianthus dichotoma plant production and Shital Pati made by co-operative farmers at FSRD site, Subarnachar, Noakhali

11.5.2. Empowerment of rural women through off-farm activities at FSRD Site: Shyamnagar, Satkhira (BINA)

Vermi compost is now very popular to every farmer and also easy to prepare with minimum cost. For empowering women and safe food production two women's were selected for this purpose from FSRD Site, Shyamnagar, Satkhira. Average total production was found 2196 kg farm family⁻¹ during Feb.2019-Jan. 2021. The average Gross return (Tk. 21960) and gross margin (Tk.15640) were found from per farm family (Table 11.94). Especially woman farmer was involved in production of vermicompost.

Table 11.94. Economic analysis of vermicompost production at FSRD Site, Shyamnagar, Satkhira during Feb. 2019-Jan. 2021

Activities	Feb.2019-Jan. 2020	Feb.2020- Jan. 2021	Total
Vermi compost production (kg)	1208	988	2196
Production cost (Tk.)	5120	1200	6320
Gross return (Tk.)	12080	9880	21960

11.6. Income enhancement

11.6.1. FSRD site: Jamla, Patuakhali

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 sub-project, an average per farm gross margin was Tk. 127620 whereas it was Tk. 223138 after intervention of the project activities (Table 11.95). The average increment of gross margin after intervention was 295% compared to before intervention.

Table 11.95. Technologies used and return from different sub-systems of integrated farming systems at FSRD site Jamla, Patuakhali during the years of February 2018 to January 2021

Component	Cost and return before intervention (Tk.)			Cost and return after intervention (Tk.)			Gross Margin increased after intervention	
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Amount (Tk.)	%
Homestead	15420	4500	10920	37980	9700	28280	17360	61.38
Field crop	63000	25400	37600	99100	39640	59460	21860	58.13
Livestock	99200	26700	72500	144773	35000	109773	37273	33.95
Fisheries	10600	4000	6600	57275	31650	25625	19025	74.24
Total	188220	60600	127620	339128	115990	223138	95518	42.80

11.6.2. FSRD site: Subornachar, Noakhali

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 sub-project, an average per farm gross margin was Tk. 100614 whereas it was Tk. 229046 after intervention of the project activities (Table 11.96). The average increment of gross margin after intervention was 128 % compared to before intervention.

Table 11.96. Technologies used and return from different sub-systems of integrated farming systems at FSRD Site, Noakhali during the years of February 2018 to January 2021

Component	Cost and return before intervention (Tk.)			Cost and return after intervention (Tk.)			Gross Margin increased after intervention	
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Amount (Tk.)	%
Homestead	6270	2199	4071	10574	3050	7524	3453	85
Nearby Homestead	13162	3865	9297	76255	45829	30426	21129	227
Field crop	149038	82862	66176	227106	109580	117526	51350	78

Component	Cost and return before intervention (Tk.)			Cost and return after intervention (Tk.)			Gross Margin increased after intervention	
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Amount (Tk.)	%
Livestock	23308	8640	14668	69510	25270	44240	29572	202
Fisheries	6822	2640	4182	58290	36390	21900	17718	424
Off-farm	4200	1980	2220	11550	4120	7430	5210	235
Total	202800	102186	100614	453285	224239	229046	128432	128

11.6.3. FSRD Site: Kaliganj, Satkhira (BRI)

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 gross margin was recorded from the livestock followed by field crop during three consecutive year's which was around 159% and 92% higher over previous intervention status of livestock and field crop, respectively. Regarding increase (%) of different component over previous status, fisheries sector demonstrated maximum increase (80%) in gross margin over previous status. However, year-round vegetables and fruits in homestead also exhibited remarkably higher economic return which was 67% higher over previous intervention (Table 11.97).

Table 11.97. Technologies used and return from different sub-systems of integrated farming systems at FSRD Site, Kaliganj, Satkhira during the years of February 2018 to January 2021

Component	Cost and return before intervention (Tk.)			Cost and return after intervention (Tk.)			Gross Margin increased after intervention	
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Amount (Tk.)	%
Homestead	234684	84842	149842	419139	169086	250052	100210	67
Field crop	256531	135986	120545	455484	223910	231621	111076	92
Livestock	2625	546	2079	7970	2592	5378	3299	159
Fisheries	311900	162218	149681	522982	252930	270052	120371	80
Total	805740	383592	422147	1405575	648518	757103	334956	79

11.6.4. FSRD Site: Shyamnagar, Satkhira (BINA)

Integration of year-round vegetables production, HYV seeds, improved cropping patterns and production technologies, de-worming, vaccination program, poultry bird rearing, 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 gross margin was recorded from homestead area which was 358% higher before intervention. Vegetables production nearby homestead, Livestock, Fisheries and off farm activities increased by 318%, 310%, 259% and 164% respectively, after intervention of technologies. Lowest gross margin (38%) was found in crop sector. The average increment of gross margin of all the components after intervention was 259% compared to before intervention (Table 11.98).

Table 11.98 Technologies used and return from different sub-systems of integrated farming systems at FSRD Site, Shyamnagar, Satkhira during the years of February 2018 to January 2021

Component	Cost and return before intervention (Tk.)			Cost and return after intervention (Tk.)			Gross Margin increased after intervention	
	Gross Return	Total Variable Cost	Gross Margin	Gross Return	Total Variable Cost	Gross Margin	Amount (Tk.)	%
Homestead	3120	1900	1220	8477	2892	5585	4365	358
Nearby Homestead	15000	4100	10900	67000	21400	45600	34700	318
Field crop	46530	20400	26130	67100	31090	36010	9880	38
Livestock	3200	1250	1950	13140	5138	8002	6052	310
Fisheries	9321	6130	3191	21230	9785	11445	8254	259
Off-farm	3500	1200	2300	8870	2800	6070	3770	164
Total	80671	34980	45691	185817	73105	112712	67021	147

12. Research Highlights

12.1. BARI Component

12.1.1. Year round vegetable production at FSRD sites, Subarnachar, Noakhali and Dumki, Patuakhali.

Title: Year-round vegetables production in homestead

Background: Homestead area is a valuable asset for the farm household in the light of changing climatic conditions which is suitable for production of different kinds of vegetables depending on the availability of different niches. In the coastal areas, the homesteads are often on raised lands and small where the potentiality of home gardening is limited to some extent. However, homestead areas at coastal ecosystem are more diverse and heterogeneous due to spatial soil variability (slightly to moderately soil salinity), lack of open sunny space, plantation of different kinds of trees haphazardly creates shady conditions, presence of coarse soil or lowlands raised by sands, etc. Moreover, models are dynamic which subjected to changing in socio-economic, environmental contexts and risks rather than static. Considering the above facts, the vegetables production models were modified consider on farmers' choice, nutritional aspects, market demand and agro-ecological suitability of the crops.

Objectives:

- To utilize maximum resources of the homestead and adjacent high lands in scientific way for growing vegetables (both leafy and high value) and fruits.

- To increase cash income and facilitates women empowerment.

Methodology: Homestead gardening based on niche /eco-system concept were studied during February 2018 to January 2021 at FSRD site, Subarnachar, Noakhali and FSRD site, Dumki, Patuakhali. Following methodologies were adopted to make the program participatory:

- A total twelve farmers from medium, small, and marginal categories were selected from each FSRD site. The selection of farmers was made on the basis of homestead suitability for vegetable production and eagerness and cooperativeness of the farmers.
- Farmers' homestead available resources, needs and choice assessment were done with active participation of the family members (both male and female) through discussion. Vegetables patterns were selected based on farmers choice and preference. However, new varieties and crops were also included after getting consent from farmers.
- OFRD, BARI supplied the critical inputs like fruit and vegetables seed/seedlings, net (for fencing), watering cane etc. Primarily, the seeds were supplied on free of cost to the farmers with condition to produce and preserve (where applicable) it for next year use. While farmers provided all kinds of labor.
- The data on total production and disposal patterns along with other qualitative data per homestead were collected and documented in a register.

Key findings: Following two vegetable models were modified at two FSRD sites of OFRD, BARI covering coastal agro-ecological zones:

Modified Lebukhali Model

Location of application: Homestead area of non-saline tidal/non-tidal medium highland of Patuakhali with similar area of AEZ-13.

Table 12.1. Modified Lebukhali Model

Niche/space		Year-round homestead vegetable pattern		
		<i>Rabi</i>	<i>Kharif I</i>	<i>Kharif II</i>
Open sunny space	Bed-1	Tomato + Spinach	Indian Spinach	
	Bed-2	Brinjal + Red Amaranth	Kangkong	
	Bed-3	Nolkhol + Coriander leaf	Stem Amaranth	Okra
	Bed-4	Cauliflower + Spinach	Okra	Red Amaranth
	Bed-5	Radish + Red Amaranth	Stem Amaranth	Red Amaranth
Trellis		-	-	Ribbed gourd /Snake gourd
Non-fruit trees		-	Sponge gourd/Yam	Sponge gourd/Yam
Pond/ditch slope		Bottle gourd/Sweet gourd	Bitter gourd	
Nearby homestead		Tomato+ Red Amaranth	Bottle gourd	

Modified Atkapalia Model

Location of application: Homestead and adjacent highlands of homestead with similar area of AEZ 18

Key characteristics of the technology:

- At least 01 (20 sq. m) to 02 dec (40 sq. m) open sunny space for optimizing of homestead land use and availability of vegetable round the year.
- One to five dec of high lands adjacent to homestead for production of high value crops (depends on farm category).
- Modification of land near homestead (raised the land towards Sorjan method) or in homestead for producing vegetables (at least 24 inches of raised bed and 3 to 4 bed) during Kharif season as well as throughout the year.

- Utilization of different unused wastelands, backyard, home boundary, house boundary, pond bank and roadside for producing of different types of tuber crops, fruits and medicinal plants, and bamboo production for adequate supply of different kinds of vitamin and good quantity of iron.
- Increased proper utilization and empowerment of women and child labour.

Production guideline: The model included nine production units under following patterns

Table 12.2. Modified Atkapalia Model

Niches/Space		Year-round homestead vegetable patterns		
		<i>Rabi</i>	<i>Kharif I</i>	<i>Kharif II</i>
Open sunny spaces	Bed-1	Coriander-Cauliflower	Brinjal-Gimakolmi	Brinjal-Gimakolmi
	Bed-2	Broccoli	Okra	Okra
	Bed-3	Cabbage/onion	Amaranth / Indian Spinach	Indian Spinach
	Bed-4	Red amaranth Brinjal	Muki Kachu	Muki Kachu
	Bed-5	Radish-Tomato/Garlic	Patshak/Indian spinach	Patshak/Indian Spinach
Roof top		Bottle gourd - Ash gourd/Indian spinach		
Pond banks/roadside/Trellis		Vegetables: Country bean, Summer Country bean, Bottle gourd, Sweet gourd. Bitter gourd, Potato Yam, Snake gourd, Ribbed gourd. Species: Perennial chilli, Trees: Bamboo, Pigeon pea, Neem		
Unproductive tree support		Potato Yam/Snake gourd/Ribbed gourd		
Partial shady area		Leaf aroid (Moulobi kachu), Ginger, Turmeric		
Marshy land		Panikachu (Latiraj),		
Fence		Summer country bean/ Yard long bean/Bitter gourd		
Homestead boundary		Naga chilli (5-10), Papaya (2-5, Elephant foot Yam (2-3), Coconut (2-5), Betelnut (3-5), Banana Local (5-10), Plantain Banana (2-3), Neem (1-2), Drumstick (1-2)		
Backyard/waste land		Elephant foot Yam, Papaya, Drumstick, Malta, Banana, Neem, Muki kachu		

Socio-economic aspects: All groups of farmers consumed more than 60% and sold more than 22% of their total vegetables production. Average cash income (vegetables and fruits) obtained from this model

Marginal farmer could earnTk. 2916.00 per year per family.

Small farmer could earnedTk. 3998.00 per year per family.

Medium farmer could earnedTk. 4320.00 per year per family.

Key words: Modified, Lebukhali, Atkapalia, model, vegetables, homestead, income.

12.1.2. Summer Tomato Production in the highlands adjacent to homestead at FSRD site, Subarnachar, Noakhali

Title: Summer Tomato Production in the highlands adjacent to homestead

Background: More than 80% farmers who lives in coastal areas are either small in some extent or marginal group of farmers. They are always enthusiastic to know something new about farming, although their farming is partly commercial with subsistence in nature. They need petty cash for moving their day to day farming which made them keen to searching technology. On the other hand, some of them have certain quantity (2 to 5 dec.) of multipurpose highland. After intervention of summer tomato under the project support, most of them interested to grow it due to high return within short time and the shade could be used as early winter

season vegetable production.

Objective: To utilize the multipurpose highlands through high value crops for best economic return

Methodology: The poly shade was constructed according to “Krishi Projukti Hatboi”, 2018. Cement made pillars were used instead of bamboo pillars for supporting the shade as well as enhanced the longevity of shade for using couple of years. During *kharif* season of 2019, three farmers were selected and in the succeeding year four farmers were engaged in summer tomato cultivation. The unit plot size was three decimals in 2019 where BARI Hybrid Tomato-8 (Summer), BARI Hybrid Tomato-10 (Summer), and BARI Hybrid Tomato-11 (Summer) were tested. During the Kharif season of 2020, best performed variety BARI Hybrid Tomato-8 (Summer) were used as planting materials due to short duration and best yielder.

Key findings: From one decimal of land farmers can earn about Tk. 4500 to Tk.5000. Moreover, the shade could be used in the early winter season vegetables production as well as Kharif season vegetables production.

Key words: Summer, Tomato, Multipurpose, Highlands

12.1.3. Movable seedbed for winter vegetables seedlings production at FSRD site Subarnachar, Noakhali

Title: Movable seedbed for winter vegetables seedlings production

Background: After intervention of the project, probably farmers have been more intending to cultivate vegetables on their high lands or modified land adjacent to homestead than ever before. Meanwhile, lack of early seedlings and supply of quality seedlings had proven as the major constraints for winter vegetables production in the coastal saline areas of Noakhali during defining recommendation domain. In addition, farmers incapacitated to install permanent structure for seedlings production due to versatile uses of accessible small-scaled high lands, land ownership pattern diversifying (sharecropper or tenant farmers), delaying cessation of the monsoonal rainfall and water stagnancy during late *Kharif-II* season. Such ecosystem, often called for contemporaneous kind of seedlings production unit that should be portable or moveable. Afterwards, the Co-PI of Noakhali site with close supervision of the PI has developed a seedbed. Finally, it was established as demonstration at field conditions by the Co-PI during last week of September 2019 which was replicated in the following year.

Objectives:

- To provide early quality winter season vegetables seedlings
- To ensure high value vegetables seedlings for income generation from multipurpose small-scaled high lands

Methodology: The seedbed was established in a sunny place where north-south opened alignment was used to minimizing shade and for keeping cool from extra heating through better air circulation. It was four feet wide and eight feet long. Initially, four-bamboo lath (5.5 feet long) was installed in the outer four side of the measured seedbed. Then, the two bamboo laths (six feet) were installed in such a way that each bamboo lath (six feet) was arrayed in the middle position of the two-bamboo lath (5.5 feet) in breadth direction. Also, the lower part of all bamboo laths was buried (0.5 feet) at below the ground. Afterwards, three light bamboo laths (9 feet) were used to keep the structure strong and rigid. In this case, upper ends of two bamboo laths (5.5 feet long) were tied up together by rope with both ends of each nine feet long bamboo lath for connected one-another. Similarly, other bamboo laths (two 5.5 feet and two 6 feet) were tied up with rest of the two nine feet long bamboo laths. Finally, boat-roof shaped roof was prepared where net (5 feet width and 10 feet long with 4"x4" mash) was tied up together with all possible place of the roof by rope. Afterwards, a flat base was prepared (above 2 feet from the ground level) by splitting portion of the bamboo. The distance of the flat base from roof was 3 feet from the corner and 3.5 feet from the middle of roof. Preparation of seedbed media was given below:

- Composed or wet straw was placed just above the flat base with 2-inch height layer.
- Afterwards, composed coco-dust was mixed with vermicompost thoroughly and major portion (80 Kg) of this mixture was broadcasted all over the straw layer randomly with the help of the hand. The mixture layer was kept 4 to 5 inch in height and the surface was leveled by the piece of flat wood (8 inch long and 6 inches wide).

- Then, Provex 200 WP (2 gm per liter water) was applied for controlling soil borne diseases and after two days root promoting hormone (Rooton @ 100 gm) was broadcasted.
- At last, seeds (treated by Provax 200 WP) were sowed in solid line where rows (row-to-row distance two inch) were oriented in north-south direction.

Key findings: From 40 sq. feet of lands farmers could earned Tk. 9622 within 32 to 35 days.

Key words: Moveable, Seedbed, Early, Winter, Vegetables

12.1.4. Vegetable cultivation under the shade of summer tomato and other adjacent areas of homestead at FSRD site, Subarnachar, Noakhali

Title: Vegetable cultivation under the shade of summer tomato and other adjacent areas of homestead

Background: Vegetables production in the coastal areas is somehow difficult due to lack of highlands, slightly to moderately saline soils, raised up the homestead areas with sand, high rainfall during rainy season, etc. Under such conditions, most of the vegetables come from either Cumilla or Mirsharai, Chattogram for selling purpose and farmers are unable to purchase the amount and diversified vegetables according to their demand. On the other hand, vegetables under the shade of previously grown summer tomato may be an option for those farmers to produce early vegetables for maximizing the initial cost of summer tomato production. On the contrary, previously used highlands adjacent to homestead were mostly used for producing radish, tomato and some other winter leaf vegetables which also available for cultivating high values vegetables. For these reasons, the vegetables were cultivated under the shade of summer tomato and adjacent areas of homestead at FSRD site, Subarnachar, Noakhali.

Objective: To utilize the multipurpose highlands in a scientific way to maximize economic return as well as meet up family demand.

Methodology: After cultivation of summer tomato, the existing structure was used to produce early winter season vegetable production in the year among all the farmers. In this case, Cole crops such as cauliflower, cabbage and broccoli were planted under the shade during 25 to 27 October 2019 and 20 to 23 October 2020. It was noted that, winter vegetable production in this area started from last week of November to second week of December, depends on the rainfalls. In such cases, seedlings produced from moveable seedbed were used for planting. Moreover, five farmers showed their interest to cultivate winter vegetables in their adjacent lands to homestead (2020-2021) and last year (2019-2020) the number was two (02). More farmers are willing to grow vegetables because of supply of quality seedlings from moveable seed bed and rainfall stop after first week of November 2020. Fertilizer was applied according to Fertilizer Recommendation Guide (BARC, 2018).

Key findings: By using the shade, farmers earned 4800 to Tk. 6000 from high value vegetables and they consumed different kinds of winter vegetables. Moreover, they also earned 4000 to Tk. 4500 during *Kharif-I* season by producing bitter gourd or snake gourd through utilizing the bamboo made shade cover as trellis.

Key words: Summer tomato, Under, Shade, winter vegetables

12.1.5. Vegetable production nearby homestead at FSRD site, Patuakhali

Title: Vegetable production nearby homestead

The thousands of hectares of lands which are overlooked due to waterlogged during the rainy season or facing drought and salinity problems in dry months seemed to offer a great promise. The introduction of the Sorjan farming method of combining vegetable crops with fish farms and raised bed vegetables production has made lands attractive to farmers seeking healthy returns. Most of the medium and small farmer of the FSRD site, Jamla, Dumki, Patuakhali has some places nearby homestead. They use these spaces in Sorjan and Raised bed vegetable production round the year or for a season only.

Objective: To utilize waterlogged areas for producing vegetables throughout the year.

relation to climatic condition. Alongside, improved varieties of different *Rabi* season crops had evaluated during 2018 and 2020 cropping season.

Objectives:

- To determine best cash crops along with the variety in relation to changing climate.
- To increase productivity as well as income of the farmers.

Methodology: The data collection processes were conformed to the following guidelines:

- Agronomic data required from each trial identified carefully which was discussed with the concerned farmers and other stakeholders.
- All data were recorded in a permanent field book during the experimental periods throughout the project intervention periods.
- Observations and opinions of different categories farmers were noted according to the crops for increasing knowledge on farming systems and changes in research emphasis.

Seed rate and fertilizer doses practiced in On-Farm Verification Trials on different *Rabi* crops are presented in Table 12.4. Moreover, Power Tiller Operated Seeder (PTOS) were used to sow the Mungbean and Sunflower seeds at FSRD site, Jamla under Patuakhali district. In case of sunflower, bird repealing at maturity stage and head threshing activities are very tedious job. For overcome these limitations, bird repealing device and sunflower thresher was supplied to the farmers that reduces losses of sunflowers. In case of Noakhali, PTOS machine was used to sow soybean, Mungbean and cowpea in all the on-farm trials and cropping pattern experiments.

Table 12.4. Seed rate and fertilizer doses practiced in On-Farm Verification Trials on different *Rabi* crops at FSRD sites Noakhali and Patuakhali (2018 to 2020)

Crops	Noakhali		Patuakhali	
	Seed rate (kg ha ⁻¹)	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha ⁻¹)	Seed rate (kg ha ⁻¹)	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha ⁻¹)
Boro Rice	28	96-24-30-10-4-0-0	-	-
Wheat	120	110-22-60-15-4-1-0	-	-
Maize	-	-	22	210-30-50-30-0-0-0
Proso millet	20	40-28-60-12-1.5-0-0	-	-
Potato	1600	110-44-120-22-4-1.5-0	-	-
Chilli	-	-	0.8 for seedling production	96-66-80-20-0-0-0
Soybean	55	12-20-22-5-24-1.3-0	-	-
Groundnut	115	12-32-42.5-56-1.70-0	120	14-35-45-50-2-0-0
Mustard	10	90-39-42.5-28-1.8-1.3-0	8	90-39-42.5-28-1.8-1.3-0
Sunflower	10	130-48-61-24-2.5-3-7	10	130-48-61-24-2.5-3-7

Crops	Noakhali		Patuakhali	
	Seed rate (kg ha ⁻¹)	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha ⁻¹)	Seed rate (kg ha ⁻¹)	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha ⁻¹)
Mungbean	28	22-28-37-24-3-1.5-0	25	22-28-37-24-3-1.5-0
Cowpea	45	16-20-19-8-0-0-0	48	16-20-19-8-0-0-0
Grasspea	55	20-15 -0-0-0-0-0	50	20-15 -0-0-0-0

Key findings: In Noakhali site, among all the on-farm verification trials highest gross margin (Tk. 93467 ha⁻¹) was observed in potato production with water hyacinth mulch. However, this production system required large amount of water hyacinth which may not be available for all categories of farmers. This type of system should be practiced in this locality in small scale rather than large scale to meet up family demand. Moreover, using of BARI Soybean-6 variety instead of Shohag and BARI Soybean-5 varieties might be better option due to higher yield and economic return. In case of pulses, gross margin of BARI Mung-6 and BARI Felon-1 varieties were much higher compared to local existing varieties. In moderate saline soils which remained fallow during *Rabi* season before project intervention, crops varieties such as BARI Surjomukhi-2 and BARI Cheena-1 found more promising compared to BARI Sharisha-14 and BARI Kheshari-2 cultivation. Moreover, it is possible to cultivate BARI Gom-25 where supplementary irrigation facility is available.

In Patuakhali site, the highest gross margin (Tk. 85500 ha⁻¹) was found from BARI Hybrid Maize-9 due to its higher yield. On the other hand, BARI Chinabadam-8 gave second highest gross margin. In case of pulses, BARI Mung-6 gave higher (Tk. 56000 ha⁻¹) gross margin compared to gross margin of BARI Felon-1. Moreover, BARI Surjamukhi-2 variety gave satisfactory yield in this site which should be promoted in large scale. On the other hand, cultivation of BARI Morich-1 was found more profitable compared to Grasspea and Mustard crops in Patuakhali site.

By using PTOS the following findings were found:

In Noakhali, PTOS were used during 2019-2020 in sowing BARI Soybean-6 variety that yielded 2.06 tha⁻¹, reduced sowing cost about Tk.2000 ha⁻¹ and increased gross margin averagely 19% over broadcasting and line sowing methods.

In Patuakhali, sowing by PTOS reduced cost about Tk. 8000 ha⁻¹ and increased average 69% gross margin over broadcasting and line sowing method. Though sowing cost reduced using in PTOS at Noakhali site, but 39% gross margin increased over traditional broadcasting method observed during 2019-2020.

During the *Rabi* season of 2018-19, cowpea was sown in line sowing methods whereas PTOS was used to sow cowpea in the following year. In that year, seed yield of cowpea was increased about 30% which offered an additional Tk.11000 ha⁻¹.

During *Rabi* season of 2018-19, BARI Surjomukhi-2 was planted in traditional line sowing method in Patuakhali site and the average yield was 1.30 t ha⁻¹ whereas in the succession year the crop was planted by PTOS. In this year 40% yield increased compared to farmers practices. Additionally, 68% reduction in sowing cost was recorded.

Key words: On-farm, Verification, *Rabi*, PTOS

12.1.7. Agronomic practices of different intercropping system at selected farmers field of FSRD site, Subarnachar in Noakhali

Title: Intercropping system

Background: Subsistence agriculture are still widely prevailing at the char land in Noakhali where during

the *Rabi* season farmers grow different spices crops (onion, chili, garlic etc.) for home consumption. On the other hand, some pulse crops (cowpea and mungbean) are also grown in non-saline to moderately saline soil for cash income as well as consumption. Intercropping, being as an efficient and most economical production system, of different categories of farmers at the saline area of Noakhali for high insurance against crop failure and overall provides greater financial stability. To meet up the households need two types of intercropping system were tested during Rabi season of 2018-19 and the best performed treatments were replicated.

Objective: To produce different crops in the same piece of land for minimizing risks of natural calamities.

Methodology: Agronomic practices of different intercropping system are presented in Table 12.5. Two types of intercropping system such as relay intercropping cowpea with garlic and cowpea with sweet potato intercropping system was tested during 2018-2019 cropping year among two farmers (one from Small farm-garlic cowpea, and one Marginal farm-cowpea with sweet potato) with unit plot size was ten (10) dec at FSRD site, Subarnachar, Noakhali. Afterwards, the best treatments were replicated among four farmers (One small and one Medium farms- garlic cowpea, and one marginal and one medium farms-cowpea with sweet potato) with average unit plot sizes were 12 and 17.5 dec, respectively during 2019-2020 cropping year.

Table 12.5. Agronomic practices of different intercropping system trials at selected farmers field of FSRD site, Subarnachar in Noakhali during 2018-2020

Treatments	Sowing method	Fertilizers doses (N-P-K-S-Zn-B kg ha ⁻¹)	Date of sowing	Harvesting date
Sole Garlic (BARI Rashun-2) Sole Cowpea (BARI Felon-1) Garlic+ Cowpea (1:1) Garlic + Cowpea (2 :1) Garlic + Cowpea (3:1) Garlic + Cowpea (4:1)	Garlic: 15 cm X 10 cm Cowpea: 30 cm X 10 cm	77-64-90-45-3-3	Garlic: 15 Dec, 18 Cowpea: 15 Jan,19	Garlic: 2 to 4 Apr.,19 Cowpea: 7Apr. to 3 May, 19
Sole Sweet potato (BARI Misti Alu -8) Sole Cowpea (BARI Felon-1) Sweet potato + Cowpea (1:1) Sweet potato + Cowpea (2:1) Sweet potato + Cowpea (3:1) Sweet potato + Cowpea (4:1)	SP: 50 cm X 30 cm Cowpea: inter space between the SP row	105-60-106-20-3-1.5	SP: 12 Dec, 18 Cowpea: 12 Jan, 19	SP: 6 to 8 Apr. 19 Cowpea: 9 Apr.to 1 May,19

Treatments	Sowing method	Fertilizers doses (N-P-K-S-Zn-B kg ha ⁻¹)	Date of sowing	Harvesting date
Garlic + Cowpea (3:1)	Garlic: 15 cm X 10 cm Cowpea: 30 cm X 10 cm,	77-64-90-45-3-3	Garlic: 20 Dec,19 Cowpea: 19 Jan, 20	Garlic: 15 April 20 Cowpea: 17 May, 20
Sweet potato + Cowpea (4:1)	Cowpea: inter space between the SP row	105-60-106-20-3-1.5	SP: 15 Dec, 19 Cowpea: 20 Jan, 20	SP: 9 Apr. 20 Cowpea: 21 May, 20

Key findings: In the year 2019-2020, intercropping of garlic and cowpea at 3:1 row ratio was more productive than growing them separately. In terms of LER, intercropping of Sweet potato and cowpea at 4:1 row ratio was more productive (1.25) than growing them separately and maximum gross return (Tk. 186462 ha⁻¹). Both the intercropping systems produced substantial yield compared to previous year yield of that particular treatment. The gross margin in both intercropping systems was higher than many other cash crops grown by the cooperative farmers and REY was also higher compared to base year of that intercropping system.

For cowpea with garlic intercropping is suitable for small-scale cultivation on land adjacent to homestead. On the contrary, cowpea with sweet potato intercropping system could be possible in large scale in the coastal areas as many farmers practicing sole sweet potato and sole cowpea in separate piece of land.

Key words: Intercropping, Garlic, Cowpea, Sweet potato, REY and LER

12.1.8. Integrated Plant Nutrition System (IPNS) and Integrated Pest Management (IPM) approaches for watermelon cultivation at FSRD site, Subarnachar in Noakhali

Title: Integrated Plant Nutrition System (IPNS) and Integrated Pest Management (IPM) approaches for watermelon cultivation

Background: Watermelon are being cultivated as cash crops where most of the farmers did not applied balance fertilizers as a result most of the fertilizers remain in the soil created pH level unstable and environmental hazard. Moreover, farmers applied too much insecticide for controlling fruit fly and other types of piercing and sucking insects. For this reason, previous experimental result on IPNS system and IPM approaches was practiced among the cooperative farmer's field.

Objectives:

- To ensure balanced fertilizers through IPNS for watermelon production and minimizing environmental hazards as well as reduced production cost.
- To produce pesticides free watermelon through IPM approaches.

Methodology: Integrated Plant Nutrition System and Integrated Pest Management approaches such as Sex Pheromone trap for Cucurbit fruit fly, collection and destruction of rotten fruits, yellow and white sticky trap for piercing and sucking type insect, Biopesticides (Ecomec, Biotrine) for mites and other sucking type insects, Biofungicide (Bio-darma) for soil bornfungus were applied in watermelon production during 2018-19, 2019-2020 and 2020-2021 at farmers' fields in FSRD site, Subarnachar, Noakhali. Nine farmers during 2018-19, seven farmers during 2019-2020 and five farmers during January, 2020- 2021 were engaged in watermelon cultivation. Management practices followed by the cooperative farmers in watermelon production are presented in Table 12.6. However, seedlings were produced through using polybag (4"x5") in the year of 2019-20 and this year four farmers raised seedlings through polybag (04 farmers) and one farmer used seedlings tray.

Table 12.6. Management practices followed by the cooperative farmers in watermelon production at FSRD site, Subarnachar, Noakhali during December, 2018 to January, 2021

Varieties	IPNS for HYG (N-P-K-S-Zn-B kg ha ⁻¹ + Cowdung tha ⁻¹)	Sowing/ Transplanting date	Date of establishing pheromone trap	Date of Harvesting
Glory, Sugar Baby, Jumbo, Sweet Jumbo, Glory Jumbo	61-29-11-8.7-1.2- 1.2-8	29 December 2018 to 19 January 2019*	25 January to 10 February, 2019	12 to 22 April, 2019
		18 January to 4 February 2020 (Seedlings age- 22 to 25 days)	30 January to 15 February, 2020	10 to 23 April, 2020
		15 December 2020** and 8 to 15 January 2020	8-9 January 2020**	Vegetative stage

*Seed was directing sowing on the pit.

** one Medium farmers producing seedlings using seedling trays.

Key findings: By using IPNS and IPM approaches yield of watermelon was increased 12 to 16% over farmers practice and gross margin increased 40 to 81%. These differences occurred due to high production cost in farmers practices as more insecticides and fungicides was used by farmers.

Key words: Watermelon, IPNS, IPM, Fruity fly, Bio-pesticides, Sticky trap

12.1.9 Quality seed production of Soybean in Kharif II season at FSRD site Subarnachar, Noakhali

Title: Quality seed production of Soybean in *Kharif II* season

Background: Soybean is the major cash crops in greater Noakhali district during the Rabi season. On the other hand, soybean is bold sized oil crop which caused germination failure as *Rabi* season harvested seeds were kept for next *Rabi* season use. However, due to early monsoon season rain occurred throughout the coastal region in couple years, unable to preserve seeds for next year cultivation. Moreover, the seeds price became high during the *Rabi* season due to less seeds were produced last year. Farmers of different parts of Bangladesh especially of Faridpur region cultivated soybean during late *Kharif* season and germination was above 90% which is blessing for the farmers of Noakhali. Unfortunately, the price was high which unable many farmers to grow soybean in *Rabi* season. To supply the seeds for upcoming *Rabi* season, late *Kharif II* season soybean seed production activity was carried out at FSRD site, Noakhali. Moreover, the cultivation of crops outside the regular crop calendar when supply is low, and prices are high can give farmers better profits.

Objective: To produce quality seeds for upcoming *Rabi* season with proper fertilizers management.

Methodology: Trial was conducted at FSRD site, Noakhali during late *Kharif II* season, 2018-2019 (one farmer), 2019-2020 (three farmers) and 2020-2021 (three farmers). Agronomic practices followed in quality seed production of soybean during late *Kharif II* season for upcoming *Rabi* season are presented in Table 12.7. All fertilizers were applied during final land preparation as 50% of the recommended doses of N-P-K-S-Zn-B kg ha⁻¹) and Bio-fertilizer (BARI RGM-901) at the rate of 1.2 kg ha⁻¹.

Table 12.7. Agronomic practices followed in quality seed production of soybean during late Kharif II season for upcoming Rabi season at FSRD site, Subarnachar, Noakhali

Years	Av. Plot size (dec)	Seed rate (kg ha ⁻¹)	Fertilizers doses (N-P-K-S-Zn-B-Mg kg ha ⁻¹)	Spacing (cm)	Date of sowing	Date of Harvesting
2018-19	10	55	12-20-22-5-2.4-1.3-5	Broadcasting	29 August, 18	17 December, 2018
2019-20	15			Line: 40 cm X 5 cm	19 August, 19	07 to 09 December 2019
2020-21	19				25 August, 20	15 December 2020

Key findings: The average yield of two years was 1.63 t ha⁻¹ where total variable cost was Tk. 41,523 ha⁻¹ and average gross return was Tk.1,20,977 ha⁻¹. The quality of the seed was increased as produced seeds had higher percentages of normal seedlings in the germination test compared to last year *Rabi* season seeds which preserved by the farmers.

Key words: Late *Kharif*, Soybean, Seeds, Upcoming, *Rabi*

12.1.10 Participatory variety selection trials on Aus Rice at FSRD site, Subornachor, Noakhali

Title: Participatory variety selection trials on Aus Rice

Background: Generally, co-operative farmers from both the location cultivated T. Aman in *Kharif II* season and other cash crops during *Rabi* season. During *Kharif I* season lands remain fallow mainly due to unfavorable soil salinity in dry season and unavailability of quality irrigation water. Moreover, medium highland (87%) is the dominant land type at the target villages (Noakhali), where flooding depth ranges from 0.3-0.9 meter and soil salinity range from slightly to moderately saline. Additionally, during the onset of monsoon the rainwater infiltrates into the dry soil and takes the salts down or washes out, created a non-saline upper layer where Aus rice can be grown. Although cultivation in such lands is being highly depends on the rainfall, minimum two crops and sometimes three crops (*Rabi* crops) are possible to grow in this category of land. All categories of farmers under the project support, are reluctant to cultivate Aus crop with their low yielding varieties due to high production cost and fluctuating of market price. On the other hand, lack of proper knowledge on modern HYV of Aus also impeding them to adopt Aus crop.

Objective: To find out the best variety/varieties according to farmers choice on their particular land types.

Methodology: During *Kharif I* season of 2019 and 2020, Participatory Variety Selection (PVS) trials of Aus rice were conducted at FSRD site, Noakhali. In first year trials, only four farmers (one from each group of marginal and small whereas two from medium) were willing to participate whereas six farmers (marginal farmer-03, small-01, medium-02) were engaged in T. Aus cultivation during the succeeding year. The following were the steps followed in general for the entire Researcher led On-farm Participatory Variety Selection trials (RPVST) at FSRD site, Subarnachar, Noakhali.

- Selection of treatments: The numbers of the treatments depend on the amount of particular crop varieties/cultivar seeds available from BRRI, BINA and the target areas. Along with the varietal trials, three cropping systems (dibbling, broadcasting and transplanting) were also tested during *Kharif* season (2019) for better understanding Aus rice production.
- Experimental design: The randomized complete block design (RCBD) was used.
- Plot size: The plot size was 15 decimals per treatment during 2019 and it was 20 decimals during 2020.
- Field operations: The lands of four trials were prepared by three times ploughing through power tiller as when the lands turn into optimum conditions for crops establishment. Fertilizers were applied according to fertilizer recommendation guide (BARC,2018) and sowing and intercultural operations were done according to Adhunik Dhaner Chash (18th Edition). Crop management practices for researcher led PVS trials are presented in Table 12.8.

Table 12.8. Crop management practices in the Researcher-led Participatory Variety Selection (RPVS) Trials at on-farm condition during *Kharif* season of 2019 and 2020

Treatments	Seed Rate (Kgha ⁻¹)	Sowing method	Date of Sowing/ Transplanting	Date of harvesting
BRRI dhan48	32 Kg	Dibbling (20 cm interval 2 to 3 seeds were placed 4 to 5 cm deep)	11 May 2019	14 August 2019
	80 Kg	Broadcasting	13 May 2019	18 August 2019
	45 Kg	Transplanting (25 cm x 4-5 cm)	22 May 2019	05 August 2019

Treatments	Seed Rate (Kgha ⁻¹)	Sowing method	Date of Sowing/ Transplanting	Date of harvesting
BRRRI dhan48, BRRRI dhan82, BRRRI dhan83, BRRRI dhan85, Binadhan-19	45 kg	Transplanting	26 to 29 May 2019	14 to 17 August 2019
BR26, BRRRI dhan48, BRRRI dhan83, BRRRI dhan85, Binadhan-19, Hydra			19 to 25 May, 2020	6 to 15 August, 2020

A Preference analysis (PA) through casting votes was conducted during a pre-harvest period when most varieties reached around 80% maturity. Male and female farmers and other stakeholders were invited to vote for most preferred (positive vote) and least preferred (negative votes) entries, using paper ballots and envelopes placed at the head of each plot. Names of entries were kept anonymous with codes used for each entry throughout the voting process. Votes were then used to identify the most and least preferred rice variety (ies) and farmers interviewed to understand the reasons behind their choices.

Key findings: Out of seven entries, only four were preferred by the farmers. In this selection process, they considered at least three characteristics. The most frequently preferred characteristics are high yielding, secondly short duration followed by stress tolerance such as minimum tolerance to salinity (2 to 4 dSm⁻¹) or drought tolerance during initial stage of crop establishment. In addition, farmers preferred varieties with sturdy culms to avoid lodging and yield losses because of occasional rain and storms that occur during the dry season. The highest yield (4.02 t ha⁻¹) was obtained from BRRRI dhan85 followed by Binadhan-19 (3.87 t ha⁻¹). Binadhan-19 is suitable for medium high lands where drainage facility exists. On the other hand, BRRRI dhan48 is not suitable for the lands where flooding depth exceed 0.8 meter as the variety is comparatively shorter than the other entities. Under such cases, BRRRI dhan85 is suitable for both types of land and could produce economically profitable yield. Furthermore, farmers preferred BRRRI dhan83 due to its short duration, grain colour, and resistance to lodging as considered important for selection of rice variety for the dry season.

Usually, farmers sow Aus rice with the first rains, which means just after soil salinity has passed its peak. Considering the fact, three cropping systems were evaluated along with the BRRRI dhan48 variety. The highest yield was found from the transplanting system followed by the dibbling system.

Key words: Participatory, Variety, Selection and Aus

12.1.11. Production Program of Aus Rice at FSRD site Jamla, Dumki, Patuakhali

Title: Production Program of Aus Rice

Background: Usually, farmers did not cultivate Aus in their lands which remained fallow during *Kharif I* season of 2019 and 2020. So, a production program of Aus rice was carried out at Jamla, Dumki, Patuakhali during *Kharif I* season with BRRRI dhan48, a mega variety of Aus for medium lowlands of coastal region

Objective: To study the varietal suitability of modern Aus rice variety in coastal environment.

Methodology: Four cooperative farmers showed their interest to cultivate Aus rice in the *Kharif* season, 2019 with average plot size was 33 dec. and it was five during 2020 with average plot size was 40 dec. Fertilizers were applied according to fertilizer recommendation guide (BARC, 2018) and sowing and intercultural operations were done according to Adhunik Dhaner Chash (18th Edition). Crop management practices are presented in Table 12.9.

Table 12.9. Crop management practices in the Production program of Aus rice during Kharif season of 2019 and 2020

Treatments	Seed rate (Kg ha ⁻¹)	Sowing method	Transplanting Date	Date of harvesting
BRRRI dhan48	40 to 42 Kg	Transplanting	24 to 28 May, 2019	27 to 30 August 2019
			15 to 20 May, 2020	14 to 16 August, 2020

Key findings: In Patuakhali, the average yield of BRRRI dhan48 was 3.56 t ha⁻¹ during *Kharif* season 2019 and it was 4.30 t ha⁻¹ during *Kharif* season 2020, which is much higher compared to yield in Noakhali Site. BRRRI dhan48 should be incorporated in the cropping patterns. Higher gross margin (Tk.24400 ha⁻¹) was obtained during 2020 cropping year as yield increased compared to previous year.

Key words: Aus, BRRRI dhan48 and *Kharif*

12.1.12. Land based T. Aman varieties production for cropping patterns at FSRD sites Noakhali and Patuakhali

Title: Land based T. Aman varieties production for cropping patterns

Background: All of the participatory farmers practiced T. Aman rice to meet up household food demand as well as to sell the additional amount at FSRD site, Noakhali. Farmers were usually cultivated Swarna and BRRRI dhan40 and obtained lower level of yield due to poor management practices. On the other hand, suitability of the lands for the particular varieties were entirely ignored by the farmers. Under this situation, varieties for different land categories were supplied under the project in both the locations during in the year of 2019 and 2020.

Objective: To find out best variety for particular land type for sustaining cropping pattern yield.

Methodology: In Noakhali, during the year of 2018, farmers were allowed to grow varieties according to their interest with modern cultivation methods were followed. Afterwards the BR23, BRRRI dhan52 and BRRRI dhan87 were cultivated on the basis of land types, water stagnant duration and drainage conditions of the particular land type.

In Patuakhali, different modern Aman rice varieties (viz., BR11, BR23, and BRRRI dhan52) were used during *Kharif II* season of 2018 and 2019 whereas BR23, BRRRI dhan52, BRRRI dhan49 and BRRRI dhan76 were cultivated during *Kharif II* season of 2020. All the Aman rice varieties were distributed to different categories of farmer's for field demonstration.

In both the locations, crops management practices were done properly.

Key findings:

Noakhali: During the Aman season of 2018, among the tested varieties Swarna produced the highest yield (4.12 t ha⁻¹) and 4.09 t ha⁻¹ obtained from BRRRI dhan52. In the year of 2019, BRRRI dhan52 gave highest yield (4.34 t ha⁻¹) whereas second highest yield (4.3 t ha⁻¹) was obtained from BRRRI dhan87. The lowest yield (3.96 t ha⁻¹) was obtained from BR23. During 2020, BRRRI dhan87 gave the highest yield compared to other two varieties. In this site, farmers usually cultivated Swarna and BRRRI dhan52 with less fertilizer management as well as ignoring the land suitability of the particular variety. For example, BRRRI dhan87 is suitable for slightly high land where watermelon-green manuring crops-T. Aman and Groundnut-T. Aus-T. Aman cropping patterns was practicing as both the *Rabi* crops required well drained medium high land. Moreover, BRRRI dhan87 is short duration compare to other varieties.

Patuakhali: In case of Patuakhali, highest yield (4.71 t ha⁻¹) was found from BRRRI dhan52 whereas farmers prefer BR11 and BR23 as water level in the field was high during the growing season during Aman season. On the other hand, yield of BRRRI dhan52 decreased and highest (4.57 t ha⁻¹) obtained from BR11

and BR23 performed the lowest yield in both the year. In 2020 cropping year, BRRI dhan52 gave highest (4.21 t ha⁻¹) yield followed by BRRI dhan49 with 4.21 t ha⁻¹. BRRI dhan76 produced third highest yield among four tested varieties.

Key words: T. Aman, Land type, Suitability and Water Stagnant.

12.1.13. Improvement of the existing Groundnut (Dhaka-1)-Fallow-T. Aman (Sharwna) cropping pattern through inclusion of T. Aus & short duration T. Aman variety at FSRD site, Noakhali

Title: Improvement of the existing Groundnut (Dhaka-1)-Fallow-T. Aman (Sharwna) cropping pattern through inclusion of T. Aus & short duration T. Aman variety

Background: Availability of sufficient food for current and future generations is critical and must be based on sustainable methods of production. This could be achieved through inclusion of crops within the cropping pattern in such a way that time of sowing of one crop will not be hampered by other crops and the whole pattern achieved higher gross margin over existing cropping pattern. For this reason, the above mentioned cropping pattern were undertaken at FSRD site, Noakhali.

Objectives:

- To increase farm productivity by introducing new crops in the existing pattern.
- To increase overall farm income.

Methodology:

Table 12.10. Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali

Observation		Improved cropping pattern			Existing cropping pattern		
Crop		Groundnut	T. Aus	T. Aman	Groundnut	Fallow	T. Aman
Variety		Dhaka-1	Binadhan-19	BRRI dhan87	Dhaka-1	-	Swarna
Date sowing/ Transplanting	2018-19	24-26/12/18	22-24/5/19	20-22/8/19	26-31/12/18	-	18-22/8/19
	2019-20	16-17/12/19	18-22/5/20	18-19/8/20	16-18/12/19	-	16-22/8/20
Seed rate ((kg ha ⁻¹))		110	40	40	120	-	42
Spacing (cm)		30×15	20×15	25×15	Randomly	-	Randomly
Fertilizer dose (N-P-K-S-Zn-B kg ha ⁻¹)		12-32-42-54-0-2	69-11-38-7-1.9-0	69-22-24-5-4-0	20-25-15-0-0-0	-	80-18-20-0-0-0
Date of harvesting	2018-19	19-22/4/19	12-14/8/19	30/11-2/12/19	18-21/4/19	-	6-8/12/19
	2019-20	8-10/4/20	8-11/8/20	23-25/11/20	9-10/4/20	-	5-9/12/20
Field duration (days)		111-113	80-82	95-100	113-115	-	108-110
Turned around time (days)		20-25	8-10	15-20	90-100	-	10-15

Key findings: This type of cropping pattern is suitable for the lands which located near canal or slightly higher than medium high land. Additionally, heavy rainfall during late December and early January is completely unfavorable to fit this improved cropping pattern in such locality. From the cost return analysis, it was observed that, improved cropping pattern performed better than the existing cropping pattern. The marginal benefit cost ratio (MBCR) was found 1.68 which indicated the superiority of the three crops pattern over farmers' two crops cropping pattern.

Key words: T. Aus, Short duration and T. Aman

12.1.14. Improvement of the existing Soybean (Shohag)-Fallow-T. Aman (BRRI dhan52) cropping pattern through inclusion of modern soybean varieties and Aus rice at FSRD site, Noakhali

Title: Improvement of the existing Soybean (Shohag)-Fallow-T. Aman (BRRI dhan52) cropping pattern through inclusion of modern soybean varieties and Aus rice

Background: Soybean is the main cash crop in the greater Noakhali district where after harvesting of soybean the lands remain fallow until *Kharif II* season rice crop cultivation. Under such situation, there is an option to inclusion of one crop in the existing cropping pattern. Moreover, farmers of this region mainly cultivated Shohag variety which was released in 1992 by BARI. By this time, three high yielding varieties have been developed by BARI. An attempt has been under taken to incorporate in the existing cropping pattern and replacing the traditional variety.

Objectives:

- To increase farm productivity by introducing new crops in the existing pattern.
- To replace the existing variety by modern high yielding variety for increasing overall farm income

Methodology: Under the above-mentioned conditions, the improved cropping pattern Soybean-T. Aus-T. Aman trials were conducted during 2018-19 to 2019-2020 cropping season. Crop managements of improved and existing cropping pattern are presented in Table 12.11.

Table 12.11 Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali

Observation		Improved cropping pattern			Existing cropping pattern		
Crop		Soybean	T. Aus	T. Aman	Soybean	Fallow	T. Aman
Variety		BARI Soybean-6	BRRI dhan85	BRRI dhan52	Shohag	-	Sharna
Date sowing/ Transplanting	2018-19	14-20/12/19	20-24/5/19	25-28/8/19	18-22/01/19	-	19-24/8/19
	2019-20	22-25/01/20	22-25/5/20	24-29/8/20	23-25/12/19		20-25/8/20
Seed rate ((kg ha ⁻¹))		45	40	40	55	-	42
Spacing (cm)		25×2	20×15	25×15	Broadcasting	-	Randomly
Fertilizer dose (N-P-K-S-Zn-B kg ha ⁻¹)		12-20-22-5-24-1.3	69-11-38-7-1.9-0	69-22-24-5-4-0	20-15-10-0-0-0	-	80-18-20-0-0-0

Observation		Improved cropping pattern			Existing cropping pattern		
Crop		Soybean	T. Aus	T. Aman	Soybean	Fallow	T. Aman
Date of harvesting	2018-19	2-5/5/19	14-16/8/19	5-9/12/19	8-15/5/19		8-10/12/19
	2019-20	7-9/5/20	17-18/8/20	8-11/12/20	9-12/5/20	-	10-13/12/20
Field duration (days)		100-105	85-87	100-110	113-117	-	108-110
Turned around time (days)		30-35	9-12	20-25	65-70	-	35-40

Key findings: In improved pattern, T. Aus (BRRI dhan85) produced grain yield of 3.93 t ha⁻¹ and BARI Soybean-6 produced 31% more yield over existing Shohag variety. Moreover, replacing of soybean variety in *Rabi* season and inclusion of T. Aus in *Kharif I* season in the existing cropping pattern increased rice equivalent yield (REY) by 73% compared to farmers' existing cropping pattern.

Key words: Shohag, T. Aus, BARI Soybean-6 and BRRI dhan85

12.1.15. Improvement of the existing Fallow - Fallow - T. Aman (BR23) cropping pattern through inclusion of underutilized cereal crop and green manuring crop at FSRD site Subarnachar, Noakhali

Title: Improvement of the existing Fallow - Fallow - T. Aman (BR23) cropping pattern through inclusion of underutilized cereal crop and green manuring crop

Background: In the char areas of Noakhali region, soil salinity increases progressively through capillary movement and reaches peak in around Mid-March to April, at the beginning of the pre-monsoon season (8.5 to 14.0 dS m⁻¹) which diminishes with the onset of monsoon (1.5 to 4.2 dS m⁻¹) and allow farmers to grow T. Aman (Sattar, 2002). The salinity stress is most pronounced in the top 10 cm of soil where large spatial variations exist though, both in the top and sub soil layers, and even within the same plot of land (Amin *et al.*, 2011). During *Rabi* season the land remains fallow due to salinity, scarcity of quality irrigable water and irrigation facilities, poor knowledge about integration and inadequate salt tolerant varieties etc. in Subarnachar upazilla where the project sites located. The predominant cropping pattern is Fallow-Fallow-T. Aman (42 %), although double cropping (Fallow-T. Aman -*Rabi* crops) is practiced in some areas. Additionally, Proso millet can escape the adverse effect of salinity due to its short duration (85-90 days) which may fit into the cropping pattern. Moreover, it can be grown in less fertile soil with minimum inputs which needed to further be testing, validation and up-scaling as cropping pattern system along with improved management practices. With the aim of increased cropping intensity in changing climate situation the mentioned cropping pattern was undertaken against Fallow-Fallow-T. Aman cropping pattern at the farmer's field under the support of the sub-project.

Objective: Increased cropping intensity in changing climate through underutilized crops

Methodology:**Table 12.12. Crop managements of improved and existing cropping pattern at FSRD site, Subarnachar, Noakhali**

Observation		Improved cropping pattern			Existing cropping pattern		
Crop		Proso Millet	Green Manure	T. Aman	Fallow	Fallow	T. Aman
Variety		BARI Cheena-1	<i>Sesbania rostrata</i>	BR23	-	-	Sharna
Transplanting/ sowing Date	2018-19	8-11/1/19	15-17/4/19	19-22/8/19	-	-	19-23/8/19
	2019-20	15-17/01/20	18-19/4/20	23-25/8/20	-	-	20-22/8/20
Seed rate ((kg ha ⁻¹))		20	38	40	-	-	42
Date of incorporation	2018-19	-	4-10/6/19	-	-	-	-
	2019-20	-	9-15/6/20	-	-	-	-
Spacing (cm)		Broadcasted	Broadcasted	25×15	-	-	Randomly
Fertilizer dose (N-P-K-S-Zn kg ha ⁻¹)		54-24-32-10-1	-	80-19-33-9-4	-	-	80-18-20-0-0
Date of harvesting	2018-19	5-9/4/19	-	15-20/12/19	-	-	10-14/12/19
	2019-20	8-11/4/20	-	17-23/12/20	-	-	11-14/12/20
Field duration (days)		82-85	50-55	115-120	-	-	108-111
Turned around time (days)		10-15	60-65	20-25	-	-	-

Key findings: In improved cropping pattern, by incorporation of Proso millet as salinity escape crops an extra 1.57 t ha⁻¹ yield was obtained. On the other hand, at the same time the land remains fallow due to high salinity progression during mid-February to March in the existing cropping pattern. Inclusion of green manuring crop reduced the amount of nitrogen fertilizer for succeeding crop and soil salinity assumes to decrease in the next year due to land coverage during *Kharif I* season. During *Rabi* season inclusion of Proso millet in alternate cropping pattern increased REY (7.42 t ha⁻¹yr⁻¹) which was about 69% higher than farmers practiced.

Key words: Millet, Greenmanure, Salinity and REY

12.1.16. Development of Potato-Mungbean-T. Aman cropping pattern against Mungbean-Fallow-T. Aman cropping pattern at FSRD site, Jamla, Patuakhali

Title: Development of Potato-Mungbean-T. Aman cropping pattern against Mungbean-Fallow-T. Aman cropping pattern

Background: In Patuakhali region, after harvesting of T. Aman lands remain fallow until sowing of Mungbean whereas after sowing of Mungbean the land was covered by the Mungbean during *Kharif I* season. Moreover, Mungbean is a short durated crops which can be adjusted by planting another crop before Mungbean.

Objectives:

- To increase cropping intensity by inclusion of new crops into the cropping pattern.

- To increase farm income

Methodology:

Table 12.13. Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Mungbean	Fallow	T. Aman	Potato	Mungbean	T. Aman
Variety		BARI Mung-6	-	Moulata	BARI Alu-73	BARI Mung-6	BRRRI dhan 52
Transplanting/ sowing Date	2018-19	3/3/19	-	28/08/19	18/12/18	01/3/19	28/8/19
	2019-20	01/3/20	-	26/8/20	16/12/19	01/3/20	25/8/20
Seed rate ((kg ha ⁻¹))		40	-	50	1800	40	40
Spacing (cm)		30×cont.	-	Random	60×25	30×cont.	20×20
Fertilizer dose (N-P-K-S-Zn kg ha ⁻¹)		22-28-22-10- 1.8-1	-	110-30-40	150-45-110- 16-2.8-1	22-28-22-10- 1.8-1	80-28-45-11- 3.5-1
Irrigation (DAS)		-	-	-	25 and 45	-	-
Date of harvesting	2018-19	15-20/5/19	-	24/12/19	25/02/19	15-20/5/19	09/12/19
	2019-20	10-15/5/20	-	20/12/20	26/02/20	10-15/5/20	09/12/20

Key findings: In developed pattern, incorporation of potato before Mungbean gave an extra yield of 21.6 t ha⁻¹ whereas Mungbean yield was decreased about 280 kg ha⁻¹ than the existing cropping pattern. In T. Aman about 47% yield increased due to incorporation of modern variety along with balance fertilizer, appropriate seedling rate and age and other management practices. Moreover, the higher total gross margin Tk. 1,97,260 ha⁻¹ and BCR 2.51 was obtained from improve cropping pattern.

12.1.17. Development of Sunflower - T. Aus -T. Aman cropping pattern against Grass pea - Fallow - T. Aman cropping pattern at FSRD site, Jamla, Patuakhali

Title: Development of Sunflower - T. Aus -T. Aman cropping pattern against Grass pea - Fallow - T. Aman cropping pattern

Background: In Bangladesh, attempts of sunflower cultivation have been initiated and area of production is increasing. Now it is being grown in 16 districts of Bangladesh and the average production is about 1.2 t ha⁻¹. There is a great scope for growing sunflower after harvest of T. Aman rice, because it is considered as moderately salt and drought tolerant crop. Growing grass pea in Patuakhali region became uncertain due to heavy rainfall during late rainy season. On the other hand, farmers of Patuakhali, practiced sunflower cultivation more than 12 years and the crop have usual marketing facility. Moreover, inclusion of another rice crop may be useful in the light of changing climate.

Objectives:

- To increase cropping intensity by inclusion of new crops into the cropping pattern.
- To increase farm income

Methodology:

Table 12.14. Crop managements of improved and existing cropping pattern at FSRD site, Jamla, Dumki, Patuakhali

Observation		Existing cropping pattern			Improved cropping pattern		
Crop		Grasspea	Fallow	T. Aman	Sunflower	T. Aus	T. Aman
Variety		Local	Fallow	Moulata	BARI Surjomukhi-2	BRRRI dhan48	BRRRI dhan52
Transplanting/ sowing Date	2018-19	16/11/18	-	11/9/19	04/01/19	01/6/19	11/09/19
	2019-20	10/11/19	-	8/9/20	15/01/20	02/6/20	13/9/20
Seed rate ((kg ha ⁻¹))		25	-	50	13	40	40
Spacing (cm)		Continuous	-	Randomly	50×25	20×15	25×15
Fertilizer dose (N-P-K-S-Zn-B kg ha ⁻¹)		13-8-15-0- 0	-	110-40-60-25	90-30-75-30-5-5	70-18-36- 10-10	90-20-45-10- 10
Date of harvesting	2018-19	21/03/19	-	26/12/19	11.04.19	03/09/19	24/12/19
	2019-20	24/3/20	-	26/12/20	18.04.20	06/9/20	29.12.20

Key findings: Replacing of Grasspea by sunflower and incorporation of Aus rice in existing cropping pattern, rice equivalent yield (REY) increased about 139% as Grasspea replacing by sunflower increased gross return Tk.57500 and Aus incorporation added extra gross return of Tk.80400. The whole pattern gross margin increased Tk.85750 over existing pattern that contributed to make more marginal benefit over marginal cost.

Key words: Sunflower, T. Aus, Grasspea and Developed pattern

12.1.18. Vaccination of livestock and poultry birds of co-operator farmers at FSRD Site: Noakhali and Patuakhali

Title: Vaccination of livestock and poultry birds of co-operator farmers

Background: Livestock and poultry rearing are common practices in the site. Livestock and poultry disease is the main problem faced by the farmers for livestock and poultry rearing. To reduce mortality, rate this program was conducted at the site. The livestock and poultries were vaccinated during 2018-2020. For cattle, vaccinated against FMD and Anthrax diseases. For poultry birds, BCRDV, RDV and Fowl pox, Fowl Cholera are vaccinated against major disease as per recommended schedule.

Objective: To reduce the mortality rate of livestock and poultry birds against major disease

Methodology: A total of 416 cattle were vaccinated against FMD and Anthrax disease; 95 goats were vaccinated against PPR diseases and 4504 poultry birds were vaccinated against major diseases respectively, during February, 2018- January, 2021 at FSRD site, Noakhali and Patuakhali. The vaccines were given according to the recommendation of DLS personnel of the respective sites.

Key findings: It was found that before vaccination, frequency and mortality rate of different disease of livestock and poultry birds were higher. After vaccination mortality rate of livestock and poultry birds reduced to 0-2% and 2.0 – 8.0%, respectively.

Key words: FMD, Anthrax, PPR, BCRDV, RDV, Fowl pox, Fowl Cholera, Duck plague, Duck Cholera, Pigeon Pox and Vaccination.

12.1.19. Improvement of cattle health by de-worming and vaccination at FSRD Site: Jamla, Patuakhali

Title: Improvement of cattle health by de-worming and vaccination

Background: The health of cattle in coastal area is very poor due to diseases and insufficient green grass. De-worming followed by vaccination program was carried out at the FSRD sites, Jamla, Dumki, Patuakhali throughout the sub-project period. Due to deworming, feed intake of cattle has increased which ultimately improve health of cattle.

Objective: To improve the cattle health and milk production

Methodology: Thirty cattle including three milch cows owned by the cooperative farmers were selected for vaccination followed by de-worming program. First and second dose of de-worming medicine was given 35-40 days interval as per body weight of the cattle recommended by concerned personnel of ULO, Dumki, Patuakhali.

Key findings: The gaining body weight of dewormed milch cow was observed as 40 g/day/cow whose average lactation yield was increased up to 0.75 L day⁻¹ over the controlled. It was observed that de-worming is an easy process to adopt with minimum cost.

Key words: Deworming and Cattle

12.1.20. Calf rearing at FSRD Site: Jamla, Patuakhali

Title: Calf rearing at farmers household

Background: Livestock are the important and valuable asset of farmers specially during critical on

unfavorable ecosystem. Livestock rearing are common practices in the coastal area. Calf rearing now a day is very important enterprise for rural farmer because of higher profit gained from short time. At the time of Eid-Ul-Azha locally reared cattle demand is higher than that comes from other areas.

Objective: To increase livestock production and income of the farmers in coastal area

Methodology: Five co-operative farmers were engaged in calf rearing. They bought calf from local market and brought up them in their yard with locally available fodder and residue of homestead. The cattle were vaccinated and dewormed as per recommended by concerned personnel of ULO, Dumki, Patuakhali.

Key findings: After six months earned Tk. 37850 per cattle

Key words: Deworming and Cattle

12.1.21. Milking cow rearing in farmers household at FSRD Site: Jamla, Patuakhali

Title: Milking cow rearing in farmers house hold

Background: Livestock are the important and valuable asset of farmers specially during critical on unfavorable ecosystem. Milking cow rearing are common practices in the coastal area. The health of cattle in coastal area is very poor due to diseases and insufficient green grass.

Objective: To increase milk production and farmers in come

Methodology: At the FSRD Site two farmers engaged in milking cow rearing and most of them have indigenous breed with average milk yield per lactation is about 300 liter/ cow/. Seeds of Napier grass provided to the cooperator farmers. The farmers grown Napier grass in their homestead and pond bank. Farmers provided green fodder to their cows as a feed.

Key findings: After intervention average milk production was found 353 liter/lactation period/cow which increased 18% over before intervention. Milk production increased due to better veterinary services, deworming and feed management, especially supply of green fodder during dry season. From total produced milk farmers consumed (170 liter) and sold (133 liter). Income from sold of milk per farm family was Tk. 6650.

Key words: Lactation period, Milk and Green fodder

12.1.22. Sonali chicken rearing in the farmers' household at FSRD Site: Jamla, Patuakhali

Title: Sonali chicken rearing at farmers' household

Background: Almost every participatory household family in the site keep small flocks of indigenous domestic fowl under a backyard management system although indigenous poultry are poor producers of eggs and meat. There has no systematic breeding program and close inbreeding occurs among indigenous stocks. Moreover, to meet the increasing demand of meat sonali chicken were distributed among the farmers of FSRD site Jamla, Dumki, Patuakhali.

Objective: To increase production and farm family income

Methodology: Systematic rearing system such as feed management, housing management, egg hatching mud pot and vaccination program for chickens was done according to plan of activities in the site for enhanced meat and egg production. The average initial body weight of sonali chicks was 62-72g during distribution.

Key findings: Body weight increased after six months was 1.87 kg. Each farm family earned gross margin Tk.10860 per year

Key words: Sonali chicken, Chick and Body weight

12.1.23. Small scale pigeon rearing in farmer's household at FSRD Site: Patuakhali and Noakhali

Title: Small scale pigeon rearing in farmer's household

Background: Pigeon's rearing is a traditional practice in rural household of coastal region. It is a low-cost income generation event of rural people. Squab's soup is very delicious and use as a tonic to gain energy escaping weakness in ill period. 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. So, pigeons were supplied to cooperative farmers of FSRD site, Patuakhali and Noakhali to increase family income through squab production and to increase nutritional supply to family members

Objective: To increase family income through squab production and to increase nutritional supply to family members

Methodology: The activity was undertaken at the FSRD site Patuakhali and Noakhali during 2020. Twenty-four pairs of adult pigeon were distributed to 12 farmers (Two pairs to each farmer) at Patuakhali and six pair distributed to one farmer at Noakhali during February to June 2020. Local breeds of pigeons were collected from the local market. The routine works of vaccination was followed regularly and natural feeds 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 to the farmers. Necessary treatments were also provided as per requirement.

Key findings:

Patuakhali: Average per farm squab production was 8 pair during February to June 2020. In four-months, squab production was 8 pair per farm of which 3 pair was stocked. Per farm squab consumption was 2 pair and sold 3 pair during 4 months. Squab stocking as well as selling increased their income. Consumption of squab also increased their nutrition. Pigeon rearing provides additional income of Tk. 3000 per farm by squab stocking and selling.

Noakhali: The present stock of the pigeon is 27 pair during January 2022- December 2020. Average squab production was 8 pair per month. They sold 75% and consumed 25% which increase their income and nutrition uptake. Pigeon rearing is profitable and it provides additional income of Tk. 1500 per farmer by squab production. The value of present stock is Tk.16200/.Besides in house pigeon rearing, almost every household are being practicing pigeon rearing and the average flock size was 4 pair.

Key words: Pigeon, Squab, Nutrition, Income and Production

12.1.24. Maximization of farmer's income through carp polyculture technique through low cost management in the perennial ponds at FSRD Site: Patuakhali and Noakhali

Title:Maximization of farmer's income through carp polyculture technique through low cost management in the perennial ponds

Background: Aquaculture is an ancient practice going on all around the world. It has been modified from time to time in order to absorb the pressure of growing population demand. Crap polyculture is based on the concept of total utilization of different trophic and spatial niches of a pond. It ensures maximum utilization of an individual aquatic body thus improving the ecosystem within. As a coastal region, Patuakhali and Noakhali is highly productive for saline water fisheries resources. In order to increase the freshwater resources, fish polyculture in ponds are indispensable.

Objective: To increase fish production and farm family income

Methodology: In Patuakhali pond size varied from 2 dec to 20 dec and average depth varied from 1 m to 1.5m round the year. Stocking density were 36 to 38 fingerlings for one decimal pond area. Whereas in Noakhali pond size varied from 05 dec to 35 dec, average depth was from 1.3m to 2m. The stocking densities of fingerlings were followed recommendation of BFRI.

Key findings:

Patuakhali: Production of fishes was found 4.32t/ha with gross margin Tk. 280500 per pond

Noakhali: Production of fishes was found 1.08t/ha with gross margin Tk. 88350 per pond

Farmers of both FSRD site were very impressed with the performance of carp polyculture. The neighbor farmers showed their keen interest to take the carp poly culture system in their ponds. Carp poly culture in the perennial pond is very promising for its higher yield as all ecological niches of pond are effectively utilized the plankton of different layer. So, farmers can be economically benefited by carp polyculture technique.

Key words: Carp, Polyculture, Stocking density, Fingerlings and BFRI

12.1.25. Maximization of farmer's income through Monoculture technique at FSRD Site: Noakhali and Patuakhali

Title: Maximization of farmer's income through Monoculture technique

Background: Background: Bangladesh is a country with thousands of rivers and ponds and is notable for being a fish-loving nation. Mono-sex tilapia, Shorputi and Shing culture is becoming more popularity culture in inland ponds. These three fish species are of great favorite to consumers because of its delicious taste and higher production rate.

Objective: To increase fish production and increase farm family consumption income

Methodology: The program was initiated at the FSRD Site, Noakhali and Patuakhali during 2018-20 to increase productivity of the existing ponds and also to increase farm income. The size of each pond was about 0.10 ha. 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, mono sex tilapia, Sorputi and Shing were released three different farmers' pond. Average weight of fingerlings was 1.0 g and stocking density was 270 per dec. Recommended management practices were followed for fish poly culture. Growth performance, production and economic return were recorded.

Key findings:

In Patuakhali, gross margin was found Tk.18,620 per pond through single culture of monosex tilapia.

In Noakhali, the gross margin was found Tk.15540 through single culture of mono-sex tilapia and Sorputi. Moreover, the gross margin was found Tk. 22640 per pond through mono- culture of shing.

Among the total production major part of production farmers were consumed a little amount of their production they could sell and distribute. Farmers of both FSRD site were very impressed with the performance of monoculture of mono sex tilapia culture. The neighbor farmer showed their keen interest to take the culture system in their ponds. Mono sex tilapia culture in both seasonal and perennial ponds is very promising for its higher yield as all ecological niches of pond are effectively utilized the plankton of different layer. Besides this, farmers keen interest to take the shing culture in perennial pond and not interested to monoculture of Sorputi.

Keywords: Monosex tilapia, Sorputi and Shing

12.2. BRRI Component

12.2.1. Year-round vegetables production in homestead area at FSRD site, Kaliganj, Satkhira

Title: Year-round vegetables production in homestead area

Background: Bangladesh is a tropical country with a huge population. To feed the ever-growing population of the country, rural agriculture sector is immensely important. After independence, agricultural sector has grown cumulatively achieving new milestones. After all this time, the productions of vegetables in the coastal region are still negligible. So, this program program was under taken to achieve the maximum vegetables production and to ensure the nutritional requirements for the farmers of coastal area.

Objectives

- a) To increase the vegetables production in the coastal region
- b) To maximize production of vegetables and farm income
- c) To increase vegetables consumption of farm family

Methodology: The experiment was conducted at FSRD site, Kaliganj, Satkhira. Nine farmers with a total of 65 decimal land areas were selected for year-round vegetables production. The vegetables were grown during February 2018-January 2021 during *Rabi*, *Khharif-1* and *Khharif-2* season. Laudove model (Table 12.15) were followed for homestead vegetables productions with some modifications as farmers' preferences, existing resources and local demand as well. Improved production practices along with improved varieties were tested to increase total vegetables production round the year using existing farm resources.

Table 12.15. Vegetables production in homestead area followed Laudove model at FSRD Site, Kaliganj, Satkhira during 2018-21

Sl. No.	Production unit	Farming practices
1.	Open land	Potato – Brinjal – Pumpkin - Arum
2.	Roof	Bottle gourd – Country beans
3.	Trellis	Bottle gourd – Cucumber - Pumpkin
4.	Partial shady area	Turmeric
		Purple yam
		Papaya
		Giant taro
		Elephant foot yam
	Ginger	
5.	Fence	Bitter gourd-Yardlong beans
6.	Marshy land	Taro, Giant Taro
7.	Homestead boundary	Papaya (5-9 plant)
		Guava (3-8 plant)
		Lemon (2-6 plant)
8.	Back yard	Drumstick (1-4 tree)
		Banana

Key findings:

- Average vegetables production and consumption of farm families increased after intervention practicing the laudove model. Before intervention, the total vegetables production was 343 Kg which increased to 490 Kg, 610 Kg and 663 Kg respectively in the following three consecutive years after intervention.
- Farmers are following the good management practices for better production
- Different niches of a homestead are being utilized for different kind of vegetables and fruit production.

Key words: Homestead production system, Year-round, Vegetables Laudove model

12.2.2. Year-round vegetables production nearby homestead area at FSRD site, Kaliganj, Satkhira

Title: Year-round vegetables production nearby homestead area

Background: Vegetable's production is an important cash income enterprise especially the southern part of Bangladesh, the acute vegetable deficit area. The relatively small area requirement coupled with strong local demand makes vegetables production profitable in the cropping system. For year-round vegetables production and to increase the production in nearby homestead area, improved production practices were introduced at FSRD site, Kaliganj, Satkhira during February 2018-January 2021.

Objectives:

- i. To ensure the vegetables availability round the year
- ii. To maximize vegetables production
- iii. To increase vegetables consumption and farm family income

Methodology: The experiment was conducted during 2018-19 at FSRD site, Kaliganj, Satkhira. Two farmers with a total of 60 decimal land area were selected. Improved production practices were introduced to increase total vegetables production round the year using existing farm resources. All management practices and fertilizers were used following respective crop recommendation. Production practices followed are presented in Table 12.16.

Table 12.16. Niches and cropping patterns followed for vegetables production in nearby homestead area at FSRD Site, Kaliganj, Satkhira during February 2018- January 2021

Sl. No.	Niches	Cropping patterns
1.	Open spaces	Cabbage/Spinach - Brinjal – Pumpkin
		Potato/Turnip - Brinjal – Ladies Finger/Carrot – Indian spinach/Red Amaranth – Yardlong bean/Taro
		Elephant Foot Yam-Tomato/Khira
2.	Stick support	Cucumber - Sponge gourd
3.	Fence/trellis	Bitter gourd -Sponge gourd

Key findings

- Average vegetables production, consumption and income were increased per farm family after intervention. Before intervention, the average vegetables production was 720 Kg which increased to 2905 Kg, 3050 Kg and 3490 Kg, respectively in the following three consecutive years.
- Average gross return increased 755% over before intervention
- Average gross margin increased 192 % over before intervention
- Farmers are following the good management practices for better production

Key words: Year-round, Nearby homestead and Vegetables

12.2.3. Spice's production in the unused shady places of homesteads at the FSRD site Kaliganj, Satkhira

Title: Spice's production in the unused shady places of homesteads

Background: Spices have been used in foods of warmer climates since ancient times for their anti-microbial and anti-oxidant properties. Spices viz. ginger and turmeric grow well in the shady places of the homestead. Farmers in this area do not cultivate anything in the shady places of the homestead. In the southwestern region, Chui jhal is one of the most popular and unique spice. The chopped stems, roots and skin of Chui plant are used while cooking food. The climatic condition of this region (Jashore, Satkhira,

Khulna and Bagerhat) supports the production of Chui jhal, which fetches high price in the market. The activity was taken to build up awareness and to show the production systems of Chui jhal, turmeric and ginger with the support of perennial trees or walls in barren lands or unused shady places in homestead area.

Objectives

- i. To utilize the available unused shady places
- ii. To establish a new regime for cultivable species in homestead area

Methodology: The study was conducted at the FSRD site Kaliganj, Satkhira during 2018-2020. Seven farmers were selected for ginger and turmeric production in shady places and eleven families were motivated for planting Chui jhal spices with the support of perennial trees and nearby walls. Chui jhal plant is one kind of climbing tree that grows in shady places. The plot size was 4m × 1.5m for both ginger and turmeric. Total area for ginger and turmeric cultivation was 100 m² and 200 m², respectively. After land preparation, sowing was done by maintaining 50 x 25 cm and 60 x 25 cm spacing for ginger and turmeric, respectively. “Pilai” (mother ginger) of ginger was harvested after 70-80 days after sowing. A total of forty-one Chui jhal vines were planted during February 2018- January 2019. The stems are still not marketable in January 2021, but the stems are growing rapidly in the shady places. All managements followed are presented in Table 12.17.

Table 12.17. Management Practices of Ginger & Turmeric at Kaliganj, Satkhira, during February 2018- January 2021

Management factors	Ginger	Turmeric
Variety	BARI Ada-2	BARI Holud-4
Seed Rate (kg/ha)	2500	2500
Seeding date	26 May-12 April	3-23 May
Spacing (cm x cm)	50 x 25	60 x 25
Fertilizer (kg/ha)*	300-270-230-110-3	220-125-260-110
Weeding	2-3	2-3
Irrigation	1-2	1-2
Pest control	1-2	1-2
Harvesting Date	14 January-3 February	14 January-16 February

* Urea-TSP-MoP-Gypsum-ZnSO₄

Key findings:

- Shady places nearby homesteads was used for spices (ginger and turmeric) production
- Chui jhal spices planted with the support of perennial trees or any dead support like walls without any additional costs
- High value spice production was increased. The cash income of the farm family also increased.

Key words: Spices, Ginger, Turmeric, Chui jhal and Shady place

12.2.4. Establishment of mini mixed fruit orchard (Mango, Litchi and Ber) in the homestead at FSRD Site Kaliganj, Satkhira

Title: Establishment of mini mixed fruit orchard (Mango, Litchi and Ber) in the homestead

Background: Fruit trees are one of the most common and efficient production units for supplying nutrition, food, timber and employing family labor. Mini orchards are often a necessity in Bangladesh for supplying

fresh fruits and ensuring the proper nutrition of the family members. To maximize the use of land resources and increase the income of coastal people, a good number of mango and litchi saplings were distributed among the cooperator farmers at FSRD Site Kaliganj, Satkhira. The mass people in that area are not conscious about their nutrition. The program was under taken to ensure proper nutrition as well as income of the cooperator farmers.

Objectives

- i. To utilize homestead farm resources to grow fruit and vegetables production
- ii. To increase income of the farm family by producing improved varieties of mango and litchi
- iii. To afford nutrition for the family members

Methodology: A total number of 75 fruit saplings (mango, litchi and ber) were distributed among the three selected farmers at FSRD Site, Kaliganj, Satkhira during 2018-2020. Farmers produced potato, pumpkin, taro, turnip and tomato in the mini orchards.

Key findings:

- Farmers produced vegetables in the mini orchards as the fruit trees are still small
- Higher productivity could be achieved by crops production in the mini orchid

Key words: Mini orchard, Fruit trees and Crop production

12.2.5. Fruit sapling plantation in the homestead area at FSRD site, Kaliganj, Satkhira

Title: Fruit sapling plantation in the homestead area

Background: Fruit trees plantation and fruit production are a valuable possession for rural farmers. As for their value, fruit trees are surprisingly easy to grow in a backyard fallow land, and their yield years' worth of plentiful fruit. They can be used as timber and wood production also. To ensure the nutritional requirements and maximize the usage of homestead area Mango and Wood apple saplings were distributed for planting in fallow lands in homestead area at FSRD site, Kaliganj, Satkhira during 2018-19.

Objectives

- i. To provide proper nutrition to the family members
- ii. To ensure the maximum utilization of the homestead area

Methodology: A total of 42 farmers were selected for different types of fruit sapling plantation at FSRD site, Kaliganj, Satkhira during Feb. 2018 – Jan. 2021. Distributed fruit tree saplings were mango, areca nut, ber, litchi, guava, sapota, tamarind, elephant's foot apple etc.

Key findings:

- Litchi shows high mortality rates
- Wood apples are good for plantation at the coastal region

Key words: Plantation, Fruit trees and Crops production

12.2.6. Improvement of existing Boro-Fallow-T. Aman cropping pattern at FSRD site, Kaliganj, Satkhira

Title: Improvement of existing Boro-Fallow-T. Aman cropping pattern

Background: The south-western part of Bangladesh covers an area of tidal saline and non-saline wetlands under different land types. In Kaliganj, Satkhira the most prominent cropping pattern is Boro-Fallow-T. Aman cropping pattern. There is a possibility to include a short duration non rice crop (mustard and Jute) between two rice. BRRI and BARI developed a number of short duration T. Aman and mustard varieties those would be easily grown in this cropping pattern and increase the total productivity. The farmers are not experienced to grow mustard between the two rice production periods, especially in the sub-project site. Therefore, this study was undertaken to fulfill the following objectives.

Objectives

- i. To increase the total production as well as more economic return
- ii. To diversify crop production and disseminate the improved cropping pattern

Methodology: The experiment was conducted during 2018-20 at FSRD site, Kaliganj, Satkhira, Two improved patterns (Mustard -Boro- T. Aman and Boro-Jute-Taman) were tested against existing Boro-Fallow-T. Aman cropping pattern. The variety of Boro rice, T. Aman rice. Mustard and Jute were BRRI dhan81, BRRI dhan75, BARI Sarisha-14 and NSC. The yield of each crop, rice equivalent yield (REY) and Gross margin were under taken for evaluation of cropping pattern. Crop management practices of improved and existing cropping pattern are presented in Table 12.18 and 12.19.

Table 12.18. Crop management practices of improved and existing cropping pattern during 2018-20 at FSRD site, Kaliganj, Satkhira

Observation	Improved cropping pattern			Existing cropping pattern	
	Mustard	Boro	T. Aman	Boro	T.Aman
Crop	Mustard	Boro	T. Aman	Boro	T.Aman
Variety	BARI Sarisha-14	BRRI dhan81	BRRI dhan75	BRRI dhan28	BRRI dhan49
Date of sowing/ Transplanting	12-20 Nov	5-10 Feb	1-14 Aug	10 Jan-7 Feb	5-20 Aug
Seed rate (kg ha ⁻¹)	6	40	40	40	40
Spacing (cm × cm)	Broadcasting	20 × 20	20 × 15	15 × 20	15 × 25
Fertilizer dose (kg ha ⁻¹)*	54-15-24-10-0- 1.7	270-90-120-90- 11-0	150-52-82-60-0- 0	270-75-90-60- 7.5-0	180-45-60-0-0-0
Date of harvesting	1-6 Feb	12-20 May	1-15 Nov	17 May-30 Apr	11-30 Nov
Field duration (days)	75-80	95-100	90-95	95-105	95-100

*Urea-TSP-MoP-Gypsum-ZnSO₄-Boron

Table 12.19. Crop management practices of improved and existing cropping pattern at FSRD site, Kaliganj, Satkhira, 2019-20

Observation	Improved cropping pattern			Existing cropping pattern	
	Boro	Jute	T. Aman	Boro	T.Aman
Crop	Boro	Jute	T. Aman	Boro	T.Aman
Variety	BRRI dhan81	NSC	BRRI dhan75	BRRI dhan28	BRRI dhan49
Date of sowing/ Transplanting	05-10 Jan	20-30 April	20-30 Aug	5-15 Jan	05-20 Aug
Seed rate (kg ha ⁻¹)	40	6	40	40	40
Spacing (cm × cm)	20 × 20	Broadcasting	20 × 15	15 × 20	15 × 25
Fertilizer dose (kg ha ⁻¹)*	270-90-120-90- 11-0	200-50-60-95- 11	150-52-82-60-0	270-75-90-60-7.5-0	180-45-60-0-0-0
Date of harvesting	10-20 Apr	10-25 Aug	20 Nov-5 Dec	10-25 Apr	11-30 Nov
Field duration(days)	95-100	110-115	90-95	95-100	96-100

*Urea-TSP-MoP-Gypsum-ZnSO₄

Key findings:

- Boro (BRRI dhan81)-Jute (NSC)-T. Aman (BRRI dhan75) found profitable cropping pattern against existing pattern. But farmers are reluctant due to operating cost and botheration to jute rotting.
- Boro (BRRI dhan81)-Mustard (BARI Sharisa-14)- T. Aman (BRRI dhan75) iwas found more preferable cropping pattern.
- Higher REY (16.76 t/ha/year and 20.56 t/ha/year) and higher gross margin (Tk.178100 and Tk.210000) were obtained from Boro (BRRI dhan81)-Mustard (BARI Sarisha-14)- T. Aman (BRRI dhan75) and Boro (BRRI dhan81)-Jute (NSC)-T. Aman (BRRI dhan75), respectively. The REY of two improved pattern 45.49% and 73.20% over than existing pattern (Boro- Fallow- T. aman rice)

Key words: Cropping pattern, Rice, Jute and Mustard

12.2.7. Improvement of existing Vegetables-Rice cropping pattern at FSRD site, Kaliganj, Satkhira

Title: Improvement of existing Vegetables-Rice cropping pattern

Background:

Farmers usually grow long duration rice variety with single vegetables in this area. There is a possibility to increase the productivity of existing vegetables - rice cropping pattern. Using short duration rice variety creates opportunity to improve existing vegetables-rice cropping pattern through introducing one more vegetable in the system. As a result, it could be increased the total productivity of the land as well as farmers' income.

Objectives:

- To increase the total production as well as farm income
- To diversify crop production and disseminate the improved cropping pattern

Methodology:

The experiment was conducted during 2018-19 at FSRD site, Kaliganj, Satkhira during February 2019-January 2020. Three improved cropping patterns (ICP) were tested against existing cropping pattern (ECP) Khira-T. Aman (BRRI dhan49) cropping pattern. Rice variety BRRI dhan75 was used for T. Aman season. In case of vegetables, brinjal and turnip with khira; pumpkin with broccoli was cultivated as relay crop in improved cropping pattern. T. Aus (BRRI dhan85) was cultivated after harvest of vegetables (Table 12.20, Table 12. 21 , Table 12. 22 and Table 12. 23)

Table 12.20. Cropping patterns followed at FSRD site, Kaliganj, Satkhira (2018-20)

Cropping patterns followed	Varieties
ECP: Khira-T. Aman	T. Aman: BRRI dhan49
ICP1: Khira+Turnip-T. Aman	T. Aman: BRRI dhan75
ICP2:Broccoli +Pumpkin-T. Aman	T. Aus: BRRI dhan85
ICP3: Khira+Turnip- T. Aus.-T. Aman	

ECP = Existing cropping pattern

ICP = Improved cropping pattern

Table 12.21. Crop management practices of improved and existing cropping pattern during 2018-19 at FSRD site, Kaliganj, Satkhira

Observation	Improved pattern			Existing pattern		
	Khira	+	Turnip	T. Aman	Khira	T.Aman
Crop	Hybrid		Hybrid	BRRI dhan75	Local	BRRI dhan49

Observation	Improved pattern			Existing pattern	
Date of sowing/ Transplanting	12 Nov	10 Dec	30 July	8 Dec	10 Aug
Seed rate (kg ha ⁻¹)	0.3	1	40	1.5	40
Spacing (cm × cm)	70 × 80	100 × 80	20 × 15	100 × 80	15 × 25
Fertilizer dose (kg ha ⁻¹)	300-250-200- 100-0-10	120-50-190-150- 0-0	150-52-82-60- 11-0	100-40-120-120- 0-0	160-45-60-37-0- 0
Date of harvesting	2 Feb-30 Apr	10 Feb-30 Mar	5 Nov	10 Feb-10 Apr	24 Nov
Field duration (days)	80-168	60-110	95	64-118	104

*Urea-TSP-MoP-Gypsum-ZnSO₄

Table 12.22. Crop management practices of improved and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2018-19

Observation	Improved pattern			Existing pattern	
Crop	Broccoli + Pumpkin		T. Aman	Khira	T. Aman
Variety	Hybrid	Hybrid	BRR1 dhan75	Local	BRR1 dhan49
Date of sowing/ Transplanting	20-21 Dec	13-15 Nov	28-30 July	3-5 Dec	3-6 Aug
Seed rate (kg ha ⁻¹)	0.40	1.5	40	1.0	40
Spacing (cm × cm)	50 × 45	100 × 80	20 × 15	100 × 80	15 × 25
Fertilizer dose (kg ha ⁻¹)	250-200-150-0- 0-12	120-50-190- 150-0-0	150-52-82-60- 11-0	100-40-120-120- 0-0	170-50-60-40-0-0
Date of harvesting	10 Mar-10 Apr	10 Feb-10 Apr	5-10 Nov	10 Feb-5 April	22-28 Nov
Field duration (days)	80-110	85-145	95	65-120	106

*Urea-TSP-MoP-Gypsum-ZnSO₄

Table 12.23. Crop management practices of improved and existing cropping pattern at FSRD site, Kaliganj, Satkhira during 2019-20

Observation	Improved pattern			Existing pattern		
Crop	Khira + Turnip		T. Aus	T. Aman	Khira	T. Aman
Variety	Hybrid	Hybrid	BRR1 dhan85	BRR1 dhan75	Local	BRR1 dhan49
Date of sowing/ Transplanting	4-6 Dec	20-25 Dec	20-24 Apr	20-23 Aug	8-10 Dec	9-12 Aug
Seed rate (kg ha ⁻¹)	1.5	2.5	40	40	1	40
Spacing (cm × cm)	100 × 80	30 × 30	15 × 20	20 × 15	100 × 80	15 × 25
Fertilizer dose (kg ha ⁻¹)	120-50-190-150- 0-0	300-250-215-0- 0-10	135-53-82-0-0-0	150-52-82-60-0-0	100-40-130-110-0- 0	17-40-60-40-0-0
Date of harvesting	6 Feb-29 Mar	10-30 Mar	12-15 July	20-22 Nov	15 Mar-8 Apr	20-24 Nov
Field duration (days)	62-116	80-100	85	92	67-120	105

*Urea-TSP-MoP-Gypsum-ZnSO₄

Key findings:

- Khira + Turnip - T. Aus-T. Aman cropping pattern was practiced and highest total REY (28.43t ha⁻¹year⁻¹) as well as gross margin (Tk.286350) were found among the three tested cropping patterns.
- Shorter duration T. Aman variety of BRRI dhan75 created an opportunity to include more crops in the existing cropping pattern

Key words: Cropping pattern, Rice, Vegetables, Khira, Turnip, Broccoli and Pumpkin

12.2.8. Development of alternate cropping pattern at FSRD site, Kaliganj, Satkhira**Title: Development of alternate cropping pattern**

Background: Agriculture is the one of the most important sectors of the economy in Bangladesh. It is the major source of livelihood in the rural areas. As a tropical country, Bangladesh has a favorable climate and soil conditions for the production of a variety of crops all the year round. In the coastal district of Satkhira, most of the available lands are saline affected. This reduces the possibility of diversified crop cultivation. In order to increase the production and increase the income of rural coastal people especially at FSRD site, existing cropping patterns should be improved. The existing system of some part of the area was two rice crops with a fallow period. As of BRRI released a number of shorter growth duration rice varieties make space to comprise more non rice crop between the two rice. This resulted in the addition of other crops and vegetables after T. Aman harvest. As well as it's a reality to produce even four crops with two rice or one rice with other non-rice cash crop. By means of this view, this study was taken with the following objectives.

Objectives

- To identify and disseminate the more productive alternate cropping pattern
- To increase the total farm productivity and income
- To diversify the crop production and cropping system

Methodology: The experiment was initiated since 2018-19 at FSRD site, Kaliganj, Satkhira. Four improved cropping patterns were tested against existing Boro-Fallow-T. Aman cropping pattern in 2018-19 where the rice variety BRRI dhan81 was used in Boro season and BRRI dhan75 was used in T. Aman season in tested improved cropping pattern. In case of vegetables, high yielding seeds were used of the respective crop. BARI Sarisha-14 and BARI Mung-6 were used in improved cropping pattern. The experiment was continued to next year using two improved cropping patterns with respective good cultivar based on the first year result (Table 12. 24, Table 12. 25 and Table 12.26)

Table 12. 24. Cropping patterns followed at FSRD Site, Kaliganj, Satkhira during 2018-20

Cropping patterns followed	Varieties
ECP: Boro -Fallow-T. Aman	Boro: BRRI dhan28 T. Aman: BRRI dhan49
ACP1: Khira+Pumpkin-Jute- T. Aman ACP2: Mustard-Mung bean-Jute –T. Aman ACP3: Cabbage+Spinach-Boro-T. Aman	Boro: BRRI dhan81 T. Aman: BRRI dhan75 Mustard: BARI Sharisa-14 Jute: Rabi-1, NSC Mungbean: BARI Mung-6

*ECP = Existing cropping pattern, * ICP = Improved cropping pattern

Table 12.25. Crop management practices of improved cropping pattern at FSRD site, Kaliganj, Satkhira, 2018-20

Observation	Improved cropping pattern-1				Improved cropping pattern-2			
	Khira + Pumpkin	Jute	T.Aman		Mustard	Mung bean	Jute	T.Aman
Variety	Hybrid	Hybrid	Rabi-1	BRR1 dhan75	BARI Sharisa-14	BARI Mung-6	NSC	BRR1 dhan75
Date of sowing/ Transplanting	7 Nov 2018	18 Nov 2018	7 Apr 2019	2 Aug 2018	18-24 Nov	10-15 Feb	20-21 Apr	14-20 Aug
Seed rate (kg ha ⁻¹)	1.5	5	6	40	6	1	6	40
Spacing (cm×cm)	100×80	100×80	Broadcasting	20×15	Broadcasting	Broadcasting	Broadcasting	20×15
Fertilizer dose (kg ha ⁻¹)*	120-50-190-150-0-0	175-175-150-100-12.5-10	200-50-60-95-11-0	150-52-82-60-0-0	54-15-24-10-0-1.7	260-90-120-112-10-0	200-50-60-95-11-0	150-52-82-60-0-0
Date of harvesting	12 Jan-4 March 2019	1 Feb-30 Mar 2019	27 July 2019	31 Oct 2018	2-9 Feb	10-15 Apr	8-12 Aug	12-20 Nov
Field duration (days)	65-117	72-132	110	91	76-77	58-59	109-112	90

*Urea-TSP-MoP-Gypsum-ZnSO₄

Table 12.26. Crop management practices of improved cropping pattern at FSRD site, Kaliganj, Satkhira, 2018-20

Observation	Improved cropping pattern-3				Existing cropping pattern		
	Cabbage + Spinach		Boro	T. Aman	Boro	Fallow	T. Aman
Variety	Atlas	Hybrid	BRR1 dhan81	BRR1 dhan75	BRR1 dhan28		BRR1 dhan49
Date of sowing/ Transplanting	7-9 Nov	12-15 Nov	12-21 Feb	1-2 Aug	20 Jan-10 Feb		01-05 Aug
Seed rate (kg ha ⁻¹)	.6	1.5	40	40	40-45		30-35
Spacing (cm×cm)	60×45	5×5	20×20	20×15	15×20		15×25
Fertilizer dose (kg ha ⁻¹)*	300-200-250-0-0-0	180-125-125-0-0-0	270-90-120-90-11-0	150-52-82-60-0-0	260-75-90-60-7.5		160-45-60-45-0
Date of harvesting	9-28 Feb	8-15 Jan	20-31 May	1-3 Nov	18 Apr-19 May		4-12 Nov
Field duration (days)	90-109	53-60	97-99	90-92	98-105		94-100

*Urea-TSP-MoP-Gypsum-ZnSO₄

Key findings:

- Short duration varieties have created opportunity for more crop production in the same pieces of land in a year.
- Inclusion of vegetables in four crops base cropping patterns has increased total productivity.

Khira + Pumpkin- Jute- T. Aman cropping pattern successfully grown and highest total whole pattern REY (35,87 t/ha/year) as all as gross margin (Tk.372400) were found among the three tested cropping patterns.

Key words: Cropping patterns and Rice equivalent yield

12.2.9. Increasing yield through intercropping different crops with Sugarcane at FSRD Site, Kaliganj, Satkhira.

Title: Increasing yield through intercropping different crops with Sugarcane

Background: Sugarcane is one of the most important cash crops in the Satkhira-Jessore region. It occupies the cultivating land almost a year, making farmers inclined to cultivate shorter duration crops. But intercropping system of sugarcane is highly profitable. To make the intercropping system popular among farmers, this program was taken in 2019-20 at FSRD Site, Kaliganj, Satkhira.

Objectives:

- i. To make sugarcane popular by practicing intercropping
- ii. To increase the production of companion crops as well as income of farmers

Methodology: The experiment was conducted during 2019-20 at FSRD Site, Kaliganj, Satkhira. Two improved systems of intercropping were tested against existing sole crop of sugar cane. Locally popular sugarcane variety Chinichapa was used in this system. Recommended crop management practices were followed of each respective cultivar (Table 12.27).

Existing System: Sugarcane (Sole crop/year)

Improved Systems: Sugarcane+Potato/Turnip

Sugarcane+Potato/Khira

Table 12.27. Managements of crop used in winter crop and sole crop (Sugarcane) at FSRD site, Kaliganj, Satkhira during 2019-20

Observation	Intercropping cropping pattern				Sole Sugarcane
	Potato	Turnip	Khira	Sugarcane	
Crop	Potato	Turnip	Khira	Sugarcane	Sugarcane
Variety	Cardinal	Hybrid	Hybrid	Chinichapa	Chinichapa
Date of sowing/ Transplanting	24-30 Nov	15-20 Nov	2-9 Dec	16-20 Nov	10-15 Nov
Seed rate ((kg ha ⁻¹)	1600	1.5	1.5	2000	2000
Spacing (cm)	60×45	5×5	100×80	45×22	45×22
Fertilizer dose (N-P-K-S- Zn-B kg ha ⁻¹)	255-125-175- 55-0	180-125-125- 0-0	120-50-190- 150-0	358-275-240-166- 7	358-275-240-166-7
Date of harvesting (range)	23-28 Feb	21-25 Feb	10 Feb-14 Mar	15 Oct-13 Nov	10-30 Oct
Field duration(days)	85-90	90-100	68-100	345	345

Key findings:

- i. As sugarcane takes longer time to harvest, it is more profitable to practiced intercropping rather than a sole crop
- ii. Highest SEY (151t/ha/year and 138.03 t/ha/year) and gross margin (Tk. 266400 and Tk. 241900) were found from Sugarcane +Potato/Turnip and Sugarcane +Potato/Khira inter cropping system. Intercropping system with sugarcane increased the total production and income more than double compared to sole sugarcane production.

Key words: Sugarcane and Intercropping

12.2.10. Production program of BRRI released T. Aman and Boro rice varieties in coastal ecosystem at FSRD site, Kaliganj, Satkhira

Title: Production program of BRRI released T. Aman and Boro rice varieties in coastal ecosystem

Background: T. Aman and Boro rice varieties are common cultivars of the coastal region of Bangladesh with Boro rice varieties being subjected to high soil salinity due to less rainfall. In order to find possible solution of this situation, a production program was taken to validate the suitability of different Boro rice varieties under different land type and ecosystem.

Objectives:

- i. To introduce high yielding varieties in the coastal region
- ii. To ensure better management practices
- iii. To facilitate seed storing practices among the farmers

Methodology: Twelve new rice varieties were evaluated in different land type at FSRD site, Kaliganj, Satkhira during 2018-20 in T. Aman and Boro season. Three to six dispersed farmers' fields were taken to validate the field performance of those tested varieties. Each farmer was considered as one replication. Almost one bigha of land was taken under cultivation of each production program. The recommended cultural practices were being followed. In T. Aman season, transplanting was done using twenty-five to forty days old seedling during July-August maintaining the spacing of 15 cm x 20 cm. T. Aman was harvested during October-November. For Boro season, transplanting was done during January-February using thirty five to forty days old seedlings maintaining the spacing of 20 cm x 20 cm. Boro was harvested during April- May (Table 12.28 and Table 12.29).

Table 12.28. Crop management practices for T. Aman rice at FSRD site, Kaliganj, Satkhira in 2018

Variety	Farmers (no.)	Area (ha)	Date of sowing	Date of harvesting
BRRRI dhan52	7	0.94	1-15 July	20 Nov-10 Dec
BRRRI dhan71	10	1.34	1 July-3 Aug	27 Oct-10 Dec
BRRRI dhan73	18	2.41	2 July-3 Aug	2-23 Nov
BRRRI dhan75	25	3.34	2-27 July	23 Oct-20 Nov
BRRRI dhan76	5	0.67	7-13 July	10-17 Dec
BRRRI dhan87	19	2.54	1-27 July	1-19 Nov

Table 12.29. Crop management practices for Boro rice at FSRD site, Kaliganj, Satkhira, 2018-2020

Variety	Farmers (no.)	Area (ha)	Date of sowing	Date of harvesting
BRRRI dhan67	13	1.74	2-13 Dec	22 Apr-5 May
BRRRI dhan81	10	1.34	7-27 Dec	26 Apr-15 May
BRRRI dhan84	4	0.54	25-30 Dec	27 Apr-5 May
BRRRI dhan86	7	0.94	15 Dec-4 Jan	2-30 May
BRRRI dhan88	3	0.40	18-22 Dec	3-8 May
BRRRI dhan89	2	0.27	27 Dec	25-27 May

Key findings

- New varieties performed well in the study areas
- Farmers are more likely to choose grain quality over yield
- In Boro season, farmers need more saline tolerant varieties for coastal region
- In T. Aman season, BRRI dhan76 cannot perform in the coastal region. While BRRI dhan52, BRRI dhan73, BRRI dhan75 and BRRI dhan87 are good for cultivation in the coastal region.
- In Boro season, BRRI dhan84 and BRRI dhan89 is not widely accepted by the farmers. BRRI dhan84 does not get good market price for its reddish color and BRRI dhan89 takes longer duration. While BRRI dhan67, BRRI dhan81, BRRI dhan86 and BRRI dhan88 are good for cultivation in the coastal region.

Key words: Rice varieties, Production program and High yielding varieties

12.2.11. Improvement of productivity in Gher system at FSRD site, Kaliganj, Satkhira

Title: Improvement of productivity in Gher system

Background: In the coastal belt of Satkhira, most of arable lands are in the Gher area. It is due to the sudden expansion of shrimp culture in 1980-90's. Gher has affected landscape of this region turning most of the area under salinity problem. In order to increase the productivity of this Gher mixed crop cultivation was introduced at the FSRD site, Kaliganj, Satkhira during 2018-19.

Objectives

- i) To maximize the productivity of Gher system
- ii) To diversify the production system and to increase the farm income
- iii) To optimize the land and water use efficiency

Methodology: Seven farmers with non-saline Ghers were selected from the FSRD site, Kaliganj, Satkhira during 2018-21. Improved production technique of fish cultivation in Ghers and vegetables on Gher dykes were carried on. Different combinations of vegetables were grown in Gher dykes round the year. T. Aman rice BR10, BRRI dhan30 or BRRI dhan73 was cultivated along with fish and sole fishes were allowed to grow during *Rabi* season. All management practices and fertilizers were used following respective component. Fish was produced in carp polyculture system. Stocking density of fish are presented in Table12.30.

Table 12.30. Stocking density of fish in Gher at FSRD site, Kaliganj, Satkhira

Name of the fish	Fingerlings/decimal (no.)
Silver carp	6-7
Catla	4-5
Rohu	5-6
Mrigal	6-7
Common/Mirror carp	2-3
Grass carp	2
Seabass (Coral)	1-2
Greenback Mullet (Faissa*)	2-4
Corsula Mullet (Khorkhullu*)	2-4
Total	30-40

Farmers use high fertilizers as well as organic manures and fish feed for fish cultivation which makes the soil fertile. In addition, less weed infestation due to fish production has positive effect on rice yield also. Perching, pheromone trap, IPM as well as mechanical technique were followed to pest control and safe food production also. Finally this activity maximized the resource use efficiency along with the total production showed high profit level.

Key findings:

- The income of farmers was increased from integrated vegetables – rice- fish culture through Gher system.
- Integrated production system to reduced impute costs
- Observed less weed infestation in the rice fields due to integrated rice- fish culture

Key words: Integration, Gher system, Rice, Fish and Vegetables

12.2.12. Intensify the productivity of Gher system through fish-duck-vegetables cultivation at FSRD site, Kaliganj, Satkhira

Title: Intensify the productivity of Gher system through fish-duck-vegetables cultivation

Background: Bangladesh is a deltaic country with the south and south-western part of the country bordered by the Bay of Bengal. In the south-western region of the country, one of the most productive lands are the Gher areas. These areas can be fully utilized through the different integrated systems of farming components.

Objectives

- i. To maximize the productivity of Gher system
- ii. To diversify the production system and to increase the farm income
- iii. To optimize the land and water use efficiency

Methodology: One Gher was undertaken to increase the production and income by introducing integrated vegetables - duck - fish culture during 2019-20. Famers usually cultivate carp fishes in their Gher. High value fish of climbing perch (Koi), Stinging catfish (Shing) and Indian catfish (Pabda) were introduced to increase the profit margin. Some carp fishes were also given to utilize the different niches of the Gher water body. Fingerlings of carp fishes and fingerlings of koi, shing and pabda were released on April 2020. Duck weed was allowed to grow in Gher for shade and feed. Stocking density of fish’s are presented in Table 12.31.

Table 12.31. Stocking density of fishes in Gher at FSRD site, Kaliganj, Satkhira

Name of the fish	Fingerlings/decimal (no.)
Climbing perch	100-120
Stinging catfish	25-30
Indian butter catfish	15
Total	140-165

The farmer was given one hundred Khaki campbell ducklings on July 2020 to rear in a shelter house over the Gher water. The floor of the duck shed was covered in gunny sack to prevent faeces to fall in the Gher. The faeces were collected to make compost and the composted faecal matter was used in the Gher dykes for vegetables cultivation. Ducks were allowed to open to nurture on Gher water body. Vegetables were produced on Gher dykes round the year in different combinations. In Boro season, BRRI dhan88 was transplanted on 29 Dec 2020 using 30 days old seedlings following standard cultural practices.

Key findings:

- The income of farmers was increased from integrated vegetables – duck- fish culture in the Gher area.
- Less weed infestation observed in the rice fields due to rice – fish culture.

Key words: Integration, Gher system, Duck, Fish and Vegetables

12.2.13. Performance of Sonali Chicken (Layer) at farm household level at FSRD site, Kaliganj, Satkhira**Title: Performance of Sonali Chicken (Layer) at farm household level**

Background: Rearing a small flock of poultry birds is a traditional practice in rural areas making it one of the most productive livestock part in Bangladesh. The production potency of any poultry bird depends on its genetic makeup and nutritional management. Poultry birds increase the subsidiary monetary engagement of rural women as well as serve the purpose of hospitality, family need and emergency also. The local (native) chicken are genetically poor producers having a range of live weight of 1.0 to 1.2 kg and laying from 42 to 45 small size eggs (35 to 40g) annually under existing scavenging system. Recent studies indicated that the egg production at smallholder level could be doubled in the existing production system through intervention of crossbreeding in the semi-scavenging poultry model. Under this activity, improved chicken breed was distributed to the participatory farmers' for rearing them in their household condition and to fulfill their nutritional requirements.

Objectives

- i. To ensure fulfillment of nutritional requirements of farm families
- ii. To make the female participants to engage in income generation
- iii. To introduce the improved chicken breed

Methodology: The program was taken at FSRD site, Kaliganj, Satkhira since 2018-19. The production program started with four farmers by giving twenty chickens each on 6th June, 2018. Another four farmers were included giving with fifteen chicks each on September 10th, 2019. Each chick was aged of seven weeks. The egg production of distributed chicks started from November, 2019. Additional seven new farmers were included in the program by giving fifteen chicks to each farmer on July 2020. The chickens were vaccinated before giving them to the farmers. The routine works of vaccination are being followed regularly. Egg production and disposal pattern were monitored regularly. Technical supports (feeding and watering management, vaccination etc.) and advice was provided from the FSRD project with the help of Upazila livestock office. Two local young farmers were trained up as local service provider (LSP) on vaccination of poultry bird and livestock. Necessary treatment was also given as per requirement and suggestion of Upazila livestock officer.

Key findings:

- Sonali chicken found a good breed for semi-scavenging farming to increase farm income
- Average egg production was increased 1837 per farm family /year due to rearing of Sonali Chicken compared to local chicken. Before intervention average egg consumption was found (101) per farm family per year. Moreover egg consumption increased to 197 eggs per farm family per year due to rearing of Sonali chicken.
- Insist female empowerment and improve family nutrition level

Key words: Sonali chicken, Homestead rearing and Semi-scavenging

12.2.14. Performance of Khaki Campbell duck rearing in the farmers' household at FSRD site, Kaliganj, Satkhira**Title: Performance of Khaki Campbell duck rearing in the farmers' household**

Background: Poultry birds rearing is an integral part of rural Bangladesh with high potential for duck rearing in coastal region of the country. Ducks are an important sub-system of poultry component as duck

rearing obviously can generate additional income of the farm families. The availability of water bodies like pond, canal, river and Ghers ensures the likelihood of duck farming in Kaliganj, Satkhira. Generally, farmers' rear native ducks those are genetically poor yielder and the economic return is negligible. That's why the production cannot reach in the optimum level. Therefore, this development activity was undertaken at FSRD site, Satkhira to introduce high yielding KhakiCampbell duck for more egg production.

Objectives

- i. To increase the egg production and income of the farm families
- ii. To ensure and increase the family nutrient consumption
- iii. To utilize family labor and female empowerment

Methodology: The program was initiated at the FSRD site, Kaliganj, Satkhira in farmers' condition since 2018. Each of the three selected farmers were given twenty Khaki Campbell female ducklings, aged of six weeks. The ducks were distributed on 6th June 2018. In 2020, three newly selected farmers were given fifteen female Khaki Campbell ducklings, aged of six weeks. The ducks were distributed on 6th June 2018 and on 28th July, 2020. The routine works of vaccination are being followed regularly. Egg production and disposal pattern was monitored regularly. Technical supports (feeding, de-worming, vaccination etc.) and all assistance were given from the FSRD project with the help of Upazila livestock office. Necessary treatment was also provided as per requirement and suggestion of Upazila livestock officer. Egg laying started from December 2018.

Key findings:

- Khaki Campbell found a good breed for semi-scavenging farming
- The average egg consumption was 31 per farm family per year before intervention, which increased to 68 eggs per farm family per year in the following years after intervention. The ducks were fully grown and increasing egg production day by day.
- Higher number of eggs was produced when supplementary feed was provided regularly to the duck.

Key words: Khaki Campbell duck, Homestead rearing and Semi-scavenging

12.2.15. Turkey rearing in household condition by cooperator farmers at FSRD Site: Kaliganj, Satkhira (BRR)

Title: Turkey rearing in household condition by cooperative farmers

Background: 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, 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 observe the performance of turkey rearing under farmers house hold condition
- ii) To increase farm family income

Methodology: The programme was conducted during Feb. 2018 to Jan. 2021 at the FSRD Site, Kaliganj, Satkhira. One hundred eighty turkey chicks were given to the selected farmer maintaining a ratio of 3:7 male and female. About 7-10 days old turkey chicks were distributed to the farmers. The routine works of vaccination were followed regularly and natural feeds (grass, Gimakolmi shak, rice grain, jackfruits etc.) were fed. After 5-6months of age female birds has 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 local hen. Necessary treatment was also given as per requirement. Farmers earned money by selling egg, adult turkey and turkey chicks.

Key findings: Average body weight 4.83 kg/bird was increased up to six months of turkey rearing under scavenging system. Gross margin was recorded from turkey rearing Tk.5360 per farmer per year. After intervention, farmers were highly satisfied with the new poultry birds for more egg and meat production, good price and additional monthly income. Turkey rearing gradually gained popularity in the project area. Due to more people were involved in Turkey rearing, the price of Turkey eggs, mature Turkeys and Turkey chickens decreased gradually. All of the farmers completely sold out their mature Turkeys and chicks. There were some reasons behind their loss of interest:

- As of more people got involved in Turkey rearing, the price of Turkey eggs, chicks & meet decreased
- Most of the people at FSRD site were financially poor resulting in less interest in buying mature Turkeys
- Turkeys take long time to get marketable size
- The taste of Turkey meats doesn't vary too much from chicken meat, so the people here are not interested of buying 7-8 kg/ Turkeys rather than buy 1-2 kg /chicken

Key words: Turkey, Scavenging, Gross return, Hatching and Body weight

12.2.16. Goat rearing in the farmer's household at FSRD site, Kaliganj, Satkhira

Title: Goat rearing in the farmer's household

Background: Goat rearing is an important part of animal husbandry that has been going on since time immemorial. Goat farming has become a profitable business and it requires a very low investment because of its multi-functional utility. Commercial goat farming business is contributing greatly to the economy and nutrition of a country. The goat is found to be an ideal milk and meat animal for rural people. Goat rearing especially for the rural poor is popular as its lesser money inputs than other animal husbandry and relatively better returns. Economically goat is ideally suited for poorer rural folk especially as goats are small sized animal, so they are easily maintained. Even they are easily maintained and cared by women and children. The importance of goat in the rural economy is evidenced by its unparalleled economic traits. For this reason, this program was taken in FSRD site, Satkhira.

Objectives

- To increase income of the farm families
- To make awareness in goat rearing for income generation

Methodology: The program was initiated at Kaliganj, Satkhira FSRD site. Five cooperative farmers under small and marginal group were selected and each of them was given two black bengal she goat collected from local market on May 2018. All ten goats were vaccinated against PPR disease. Extensive and semi-intensive systems of goat rearing were being followed. The routine works of de-worming are being followed regularly. Technical supports (feeding, de-worming, vaccination etc.) and advice were also given regularly. Necessary treatments were also provided as per necessity with the help of local Livestock office.

Key findings:

- Average gross returns of a goat were Tk.8523 and average gross margin was Tk.4458 after one year of rearing. Some goat has third progeny and some have second. With the improved breed, adequate feed supplement and proper management the average gross margin has increased (91.18%).
- Goats have very low maintenance cost

Key words: Goat and Homestead rearing

12.2.17. Fish polyculture in saline Gher system at FSRD site, Kaliganj, Satkhira

Title: Fish polyculture in saline Gher system

Background: Gher farming is a traditional agriculture system in Bangladesh. Production of *Penaeus monodon* (black tiger shrimp) or ‘Bagda’, mainly takes place in low land rice fields that are converted into shrimp ponds. These ponds are known as ‘Ghers’. Nowadays, most farmers cannot grow rice anymore at all, as saline water intrusion has made their land unsuitable for rice farming. This is due to the sea level rise in the coastal region of Bangladesh. Saline water is moving further inlands, forcing more farmers to stop farming rice and making them dependent on the production of *P. monodon*. In order to, increase productivity and decline their reliance on shrimp; fish polyculture in gher systems were introduced.

Objectives

- a) To increase farmers’ fish production
- b) To improve the management practices in the farmers Ghers
- c) To introduce successful fish polyculture in Gher system

Methodology: This program was initiated at FSRD site, Kaliganj, Satkhira in 2018. One non-saline and five saline gher were taken in this study. Eleven species of fish and one species of Tiger shrimp (Bagda) namely, Rohu, Catla, Silver carp, Grass Carp, Tilapia, Flathead Grey Mullet (Vangal), Seabass (Coral), Greenback Mullet (Faissa), and Corsula Mullet (Khorkhullu) were distributed interchangeably during 2018-19. Each year, all of the six farmers completely harvested their Ghers in January-February. The farmers again stocked fish in March-July, 2019-20. The fish culture system was semi-intensive. Overwintered carp fishes were added in the saline Ghers during June-July, when the salinity of Ghers dropped to 3-6 dS/m. Low salinity persisted till November-December of the year. Average Gher size was around 136 decimals, while Gher size ranged from 80 to 180 decimal. Their production and economic returns were recorded. Usually, saline Ghers are used for Bagda and Seabass culture. We introduced different high value fishes like Gulio Catfish (Tengra), Corsula Mullet (Khorkhullu), Flathead Grey Mullet (Vangal) and Greenback Mullet (Faissa) as well as carp fishes during low saline period in the saline Gher system. The stocking density of fingerlings were little bit higher than recommendation due the local situation and farmers’ privilege. After the first year, farmers were interested to stock fishes on their own management. Stocking density of fish in Gher are presented in table Table 12.32.

Table 12.32. Stocking density of fish in Gher at FSRD site, Kaliganj, Satkhira

Non-saline gher		Saline gher	
Name of the fish	Fingerlings/decimal (No.)	Name of the fish	Fingerlings/decimal (No.)
Silver carp	6-7	Tiger shrimp (PL)	40-50
Catla	4-5	Seabass (Coral*)	1-2
Rohu	5-6	Tilapia	15-20
Mrigal	6-7	Greenback Mullet (Faissa*)	3-4
Common/Mirror carp	2-3	Corsula Mullet (Khorkhullu*)	3-4
Grass carp	2	Flathead Grey Mullet (Vangal*)	0.14-0.17
Total	25-30	Total	62-80

*Fingerlings were collected from natural sources

Key findings:

- Farmers practiced polyculture in their Ghers
- Higher production achieved following polyculture in Ghers. Following polyculture in Ghers, fish production increased 6.40 t ha⁻¹ which was 62.84% higher than before intervention.

Key words: Gher and Fish polyculture

12.2.18. Fish polyculture in mini pond at FSRD site, Kaliganj, Satkhira

Title: Fish polyculture in mini pond

Background: Aquaculture is an ancient practice going on all around the world. It has been modified from time to time in order to absorb the pressure of growing population demand. Fish polyculture is based on the concept of total utilization of different trophic and spatial niches of a pond. It ensures maximum utilization of an individual aquatic body thus improving the ecosystem within. As a coastal region, Satkhira is highly productive for saline water fisheries resources. In order to increase the freshwater resources, fish polyculture in ponds are indispensable.

Objective: To increase fish production and income

Methodology: Seven farm families having perennial pond were selected at FSRD site, Kaliganj. The study was started since 2018 and the program is being continuing. During 2018-19, ten species of fish namely Rohu, Catla, Mrigal, Silver carp, Grass carp, Mirror carp were distributed interchangeably with Indian carps being common. Pond size was ranged from 15 to 40 decimal. Two farmers were encouraged to cultivate high value fish species such as Climbing perch, and Stinging cat fish in their ponds. The stocking density of fingerlings was little bit higher than recommendation due the local situation and farmers' privilege. Their production and economic return were recorded regularly. Stocking density of fish in mini pond is presented in Table 12.33.

Table 12.33. Stocking density of fish in mini pond at FSRD site, Kaliganj, Satkhira

Carp polyculture		Koi-Shing culture	
Name of the fish	Fingerlings/decimal (No.)	Name of the fish	Fingerlings/decimal (No.)
Silver carp	6-7	Climbing perch	100-120
Catla	4-5	Stinging cat fish	25-30
Rohu	5-6		
Mrigal	6-7		
Mirror carp	2-3		
Grass carp	2		
Total	25-30	Total	125-150

Key findings:

- Farmers practiced polyculture in their mini ponds
- Higher production rates achieved in polyculture system

Key words: Mini pond and fish Polyculture

12.3. BINA Component

12.3.1. Year-round vegetables production in homestead area at the FSRD Site Shyamnagar, Satkhira

Title: Year-round vegetables production in homestead area

Background: In the coastal 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:

- Production of high value vegetables in fallow land of homestead with a view to increase income.
- To utilize homestead resources in scientific way for producing fresh vegetables.
- 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 Shyamnagar, Satkhira during 2018-2021. BARI developed 'Laudove' model (Table 12.34) was used for year round vegetables and fruit production at homestead area. Seeds of different vegetables were distributed among the twelve farmers. For implementing Laudove model, five beds were prepared by each farmer. Intercultural operation and management practices were done by the farmers following recommended practices.

Table 12.34. Loudove model for year-round vegetables and fruit production in homestead area at the FSRD Site Shyamnagar, Satkhira

Space		Rabi	Kharif-1	Kharif-2
		October- March	April-June	July-September
Open sunny space	Bed-1	Red Amaranth	Red Amaranth	Indian spinach
	Bed-2	Spinach	Okra (Hybrid)	Coriander
	Bed-3	Cabbage	Amaranth	Brinjal (local)
	Bed-4	Cauliflower	Elephant foot taro	Elephant foot taro
	Bed-5	Knolkhol	Elephant foot taro	Elephant foot taro
One tree support		Chuijhal		
House Roof		Bottle gourd (Local)	White gourd (Hybrid)	White gourd
Trellis			Bitter gourd	
Partial shady area		Leaf aroid (Moulavikachu)		
Marshy land		Panikachu		
Home Boundary/backyard		Papaya (Hybrid)		
Home Boundary Fence			Yard long bean (Hybrid)	Sponge gourd (Hybrid)

Key findings: Homestead vegetable production as well as consumption, distribution and selling increased after intervention. Each farmer on an average produced about 306 kg, 459 kg and 414 kg and sold 173 kg, 302 kg and 258 kg of vegetables in the 2018-19, 2019-20 and 2020-21, respectively which are higher than before intervention. At the first year (2018-19) farmers were obtained 49 kg of fruits among which consumed 25 kg, distributed 8 kg and selling 16 kg. At the second year (2019-20) farmers produced 87 kg

fruits among which consumed 37 kg, distributed 13 kg and sold 47 kg. Average cost of production per farmer per year was Tk. 1738 and average gross return from vegetables production at the homestead was Tk. 6122.

Key words: Laudove model, Vegetables, Homestead, Consumption, and Income.

12.3.2. High value vegetable production nearby homestead at FSRD site Shyamnagar, Satkhira

Title: High value vegetable production nearby homestead

Background: Farmers in this area use their nearby homestead area for tradition vegetables cultivation in traditional ways. On the other hand, high value vegetable gives much more benefit to the farmers than the traditional vegetables. 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 introduce commercial agriculture
- ii) To increase farmer's income

Methodology: The activity was conducted during 2019-20 at the FSRD Site Shyamnagar, Satkhira district. In the *rabi* season vegetables cabbage, cauliflower, broccoli, Brinjal and tomato were cultivated followed by brinjal, Okra, bitter gourd, watermelon and sweet gourd during kharif season. The total size of the plot was 0.62 ha. Previously this land was used for traditional vegetable 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: Cultivation of high value vegetables in nearby homestead found very much profitable. Before intervention total net return was Tk. 67519 and after intervention it increased to Tk. 419629.

Key words: High value and Net return.

12.3.3. Improvement of the existing Boro-Fallow-T. Aman cropping pattern by improved Boro-Mustard-T. Aman cropping pattern at the FSRD Site Shyamnagar, Satkhira

Title: Improvement of the existing Boro-Fallow-T. Aman cropping pattern by improved Boro-Mustard-T. Aman cropping pattern

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. BINA has developed short duration, pest and disease resistant mustard varieties which are agro economically suitable and profitable.

Objectives:

- a) To validate different cropping patterns by introducing short duration variety of mustard
- 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 2018-2020 at the FSRD Site Shyamnagar, Satkhira. Agronomic performances of improved and existing cropping patterns are presented in Table 12.35. Improved cropping pattern Mustard-Boro-T. Aman, was tested against existing Boro-Fallow-T. Aman cropping pattern. For each pattern three dispersed farmers were treated as replication. Rice variety Binadhan-10 was used in Boro season. Binadhan-17 was used in T. Aman and Binasharisa-9 was used in Rabi season. Average size of the plot was one bigha per farmer. The management practices followed accordingly.

Table 12.35. Agronomic performance of improved and existing cropping pattern at FSRD Site, Shyamnagar, Satkhira.

Observation	Improved cropping pattern			Existing cropping pattern		
	T. Aman	Mustard	Boro	T. Aman	Fallow	Boro
Variety	Binadhan-17	Binasarisha-9	Binadhan-10	Jamaibabu	Fallow	Binadhan-10
Date of sowing/ Transplanting	08-07-18/ 30-07-18	10-11-18	15-12-18/ 28-01-19	01-07-18/ 30-07-18	-	14-12-18/ 28-01-19
Seed rate ((kg ha ⁻¹))	25-30	7.5	25-30	25-30	-	25-30
Spacing (cm)	20cm x 15cm	Broadcast	20 × 15	20cm x 15cm	-	20 × 15
Fertilizer dose (N-P-K-S- Zn-B kg ha ⁻¹)	120-150,80- 100,30-35,25- 35,1.0-4.0	190-197,148- 155,74-85,100- 110,4.5-5.0,9.0- 10.0	210-230,110- 120,60-80,45- 50,4.0-4.5	130-170,90- 110,35-45,30- 35,1.0-4.0	-	210-230,110- 120,60-80,45- 50,4.0-4.5
Date of harvesting (range)	03-11-18	25-01-19	26-04-19	10-11-18	-	24-04-19
Field duration (days)	94	76	90	101	-	90
Turned around time (days)		7	3	60-65	-	09-12

Key findings: The whole pattern gross margin was higher in improved cropping pattern (Tk.144182 /ha) compared to the existing cropping pattern (Tk.94297 /ha). The marginal benefit cost ratio (MBCR) was found 1.9 and 1.92, respectively in 2018-19 and 2019-20 which indicated the superiority of improved (Mustard -Boro-T.aman) three crops based pattern over farmers' practiced existing (Fallow-Boro-T.Aman) pattern.

Key words: MBCR, Gross margin, Yield, Improved pattern and Farm income.

12.3.4. Production program on BINA released rice variety at the FSRD Site Shyamnagar, Satkhira

Title: Production program on BINA released rice variety

Background: Boro-Fallow-T. Aman is the most dominant cropping pattern of Shyamnagar upozila of Satkhira district. Farmers are growing Boro rice in medium high and lowland 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, Bangladesh Government has been trying to reduce the Boro rice cultivation in the country for last few years. However, Aman rice production might be an alternative way to save underground water. Production of short duration less water required rice instead of Boro is a good option to conserve ground water. Keeping this view in mind the present study was undertaken to evaluate the suitability and varietal performance of modern Aman rice.

Objectives:

1. To investigate the suitability of BINA developed rice in this region
2. To find out suitable Aman rice variety (s) for this region and to evaluate farmers' response.

Methodology: Production program of Aman rice was carried out at FSRD Site Shyamnagar Satkhira during 2019 to 2020 to study the suitability and varietal performance of modern Aman rice in this location. Aman rice varieties Binadhan-11 was randomly distributed to different farmer's field for demonstration. Average size of the plot was one bigha (35 decimal) per farmer. Date of seeding, transplanting, weeding,

fertilization, harvesting and yield data was collected. Cultivation and fertilization practices were done according to BINA recommendation. Seeding and maturity date for 2019 to 2020 are given in the Table 12.36.

Table 12.36. Production of Aman rice at FSRD site, Shyamnagar, Satkhira, 2019-20

Crops & variety	Days to maturity	Seeding date	Harvesting date
Rice (Binadhan-11)	120	12-07-19	10-11-19

Key findings: The average yield of Binadhan-11 was 4.92 t/ha with gross return was 98020 Tk. ha⁻¹. The total cost of production, gross margin was 54530 Tk. ha⁻¹ and 43490 Tk. ha⁻¹ respectively. The Benefit Cost Ratio was 1.8.

Key words: Aman, rice, Variety, Yield and Gross margin

12.3.5. Vaccination program for cattle, goats and chickens at FSRD Site Shyamnagar, Satkhira

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.

Methodology: The vaccination activity was conducted at the FSRD Site Shyamnagar, Satkhira 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.

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 and Disease

12.3.6. Turkey rearing under scavenging system at farmer's homestead at FSRD Site Shyamnagar, Satkhira

Title: Turkey rearing under scavenging system at farmer's homestead

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, 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:

- iii) To check the feasibility of turkey rearing under rural condition
- iv) To increase household income through empowering rural women

Methodology: The programme was conducted during 2018 to 2020 at the FSRD Site Shyamnagar, Satkhira. Fifty turkey chickens were given to the selected farmer maintaining a ratio of 3:7 male and female. About 7-10 days 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 body weight 6.0 kg bird⁻¹ was increased up to six months of rearing under scavenging system. Net income from turkey rearing was Tk. 269650, Tk. 350545 and Tk. 141550 during the year 2018, 2019 and 2020, respectively.

Key words: Turkey, Scavenging, Net income, Hatching and Body weight

12.3.7 Sonali chicken rearing at Farmers' household at FSRD Site Shymnogor, Satkhira

Title: Sonali chicken rearing 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.

Methodology: The program was implemented at FSRD Site, Shyamnagar, Satkhiraduring 2018-2020. Twenty, 30 and 40 chicks were given to the 12 selected farmers during 2018, 2019 and 2020, respectively. About 20-25 day old chicks were supplied to the farmers. The routine works of vaccination are being followed regularly and natural feeds where 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, 1.19 kg and 1.26 kg respectively in three consecutive years. Average gross return per farmer in the year 2018, 2019 and 2020 were Tk. 4200, Tk. 6100 and Tk. 8400, respectively. Average gross margin per farmer in the year 2018, 2019 and 2020 were Tk. 49300, Tk.56700 and Tk.67500, respectively.

Key words: Sonali, Chicken, Gross margin and Body weight

12.3.8.Small scale pigeon rearing in the farmer's household at FSRD Site Shyamnagar, Satkhira

Title: Small scale pigeon rearing in the 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, Shyamnagar, Satkhira. Pigeons were distributed for increase family income through squab production and to increase nutritional supply to family members.

Methodology: The activity was undertaken at the FSRD Site, Shyamnagar, during 2019-2020. Twelve pairs of adult pigeon were distributed among six farmers (Two pairs to each farmer) during December 2019. 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 680g. 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 per year.

Key words: Pigeon, Squab, Nutrition, Income and Production

12.3.9. Carp polyculture in farmer's seasonal pond at FSRD Site Shyamnagar, Satkhira

Title: Carp polyculture in farmer's seasonal 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 carp and Shorputi. These fish are commonly grown together (known as polyculture) and these multispecies 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.

Methodology: The program was initiated at the FSRD Site, Shyamnagar, Satkhiraduring 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 culture. The size of each pond was about 0.13ha. 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 poly culture. Growth performance, production and economic return were recorded.

Key findings: Irrespective of fish species, initial average size and weight was 5.0 cm and 29.62 g respectively. The highest body weight gained was found in Mrigal (764.60 g) followed by silver carp, rohu and the lowest was found in shorputi (414.22g). The average highest net return per farmer was found in the year 2020 (Tk. 272522 ha⁻¹) and the lowest net return was found in the year 2018 (Tk. 122000 ha⁻¹).

Key words: Fish, Net return, Production and Pond

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					
1. Furniture	17	132000	17	130000	
2. Computer and accessories	10	560300	10	540700	
(b) Lab & field equipment					
(c) Other capital items	4	114400	4	113200	

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	100%
2. Desktop Computer	2	120000	2	120000	
3. Laser Printer	2	40000	2	40000	
4. UPS	2	20000	2	20000	
5. Scanner	2	20000	2	20000	
(b) Field equipment	GD2				
1. Digital Camera and accessories	2	75000	2	75000	100%
2. Soil Moisture Meter	2	135000	2	135000	
(c) Office equipment					
1. Bicycle	4	60000	4	60000	100%
2. Motorcycle	2	350000	2	350000	

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	8	1,39,200	8	1,39,209	Done

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(b) Equipments, Tools etc.	6	1,85,000	6	1,84,655	Done
(c) Small transport	3	1,80,000	3	1,79,600	Done

Table B.1.4. Procurement of equipment and capital items of BINA component

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
a) Furniture	-	-	-	-	-
b) Equipment, Tools, etc. (laptop, printer, EC meter)	03	380000	03	379863	-
c) Small Transport (Two-wheeler): Motor cycle, Bi-cycle	02		02		-

2. Establishment/renovation facilities: Not applicable.

Description of Facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

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

Table B.3.1. Information on training/workshop/meeting organized by BARC

Description	Number of participants			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training on Farming System Research and Development	80	10	90	3 day long three training	One batch for scientist and two batches for scientific assistant and sub assistant agriculture officer
(b) Workshop	195	20	215	Daylong 5 workshop	
(c) Others (if any) Meeting	36	3	39	Day long three meeting	

Table B.3.2. Information on training/workshop/field days arranged by BARI

Description	Number of participants			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	70	30	100	01 (one) day per training	Five (05) farmers trainings
(b) Workshop					
(c) Others (if any)	269	31	300	01 (one) day per field day	Three (03) field days

Table B.3.3. Information on training/workshop/field days arranged by BRRl

Description	Number of participants			Duration (Days)	Remarks
	Male	Female	Total		
(a) Training	100	80	180	6	Done
(b) Workshop	46	8	54	1	Project completion workshop was done

Table B.3.4 Information on training/workshop/method demonstration/field day/meeting organized by BINA

Description	Number of participant			Duration (Days)	Remarks
	Male	Female	Total		
a) Training	25	10	35	01 (Each training)	Three farmers training conducted.
b) Workshop	-	-	-	-	-
c) Others (if any) Field day	60	30	90	01 (each field day)	Seven field days were conducted.
Meeting to exchange views	25	10	35	01 (each field day)	Six meetings to exchange views with farmer conducted

C. Financial and physical progress**Table C.1. Combined financial and physical progress***Fig in Tk*

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	9415752	8978427	8978427	0	100	
b. Field research/lab expenses and supplies	10150684	10372076	10372076	0	100	
c. Operating expenses	3713737	3284610	3284610	0	100	
d. Vehicle hire and fuel, oil & maintenance	2810229	1855160	1855160	0	100	
e. Training/workshop etc.	4305524	2471524	2471524	0	100	
f. Publications and printing	500000	980874	980874	0	100	
g. Miscellaneous	565610	589152	589152	0	100	
h. Capital expenses	2200464	2667364	2667364	0	100	
Total	33662000	31199187	31199187	0	100	

Table C.2. Financial and physical progress of BARC Component*Fig in Tk*

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	3482656	3482656	3482656	0	100	
b. Field research/lab expenses and supplies	446464	446464	446464	0	100	

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
d. Vehicle hire and fuel, oil & maintenance	174931	174931	174931	0	100	
e. Training/workshop etc.	1419450	1419450	1419450	0	100	
f. Publications and printing	896874	895874	895874	0	100	
g. Miscellaneous	224090	224090	224090	0	100	
h. Capital expenses	783900	783900	783900	0	100	
Total	8100000	8092180	8092180	0	100	

Table C.3. Financial and physical progress of BARI Component

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	2586214	2586214	2586214	0	100	
b. Field research/lab expenses and supplies	4797810	4797810	4797810	0	100	
c. Operating expenses	1417126	1417126	1417126	0	100	
d. Vehicle hire and fuel, oil & maintenance	817850	817850	817850	0	100	
e. Training/workshop/ seminar etc.	533000	533000	533000	0	100	
f. Publications and printing	0	0	0	0	100	
g. Miscellaneous	130000	130000	130000	0	100	
h. Capital, expenses	1000000	1000000	1000000	0	100	
Total	11282000	11282000	11282000	0	100	

Table C.4. Financial and physical progress of BRRI Component

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	1371503	1371503	1371503	0	100	
b. Field research/lab expenses and supplies	2740006	2740006	2740006	0	100	
c. Operating expenses	543014	542669	542669	0	100	
d. Vehicle hire and fuel, oil & maintenance	372379	372379	372379	0	100	
e. Training/workshop etc.	294024	294024	294024	0	100	
f. Publications and printing	50000	50000	50000	0	100	
g. Miscellaneous	105610	105062	105062	0	100	
h. Capital expenses	503464	503464	503464	0	100	
Total	5980000	5979107	5979107	0	100	

Table C.5. Financial and physical progress of BINA Component

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund Received (Tk.)	Actual expenditure	Balance/ unspent (Tk)	Physical progress	Reason for deviation
a. Contractual staff salary	2004710	1538054	1538054	0	100	
b. Field research/lab expenses and supplies	2612868	2387796	2387796	0	100	
c. Operating expenses	677422	660000	660000	0	100	
d. Vehicle hire and fuel, oil & maintenance	495000	490000	490000	0	100	
e. Training/workshop etc.	225000	225050	225050	0	100	
f. Publications and printing	75000	35000	35000	0	100	
g. Miscellaneous	130000	130000	130000	0	100	
h. Capital expenses	380000	380000	380000	0	100	
Total	6600000	5845900	5845900	0	100	

D. Achievement of Sub-project by objectives (Tangible form): Technology generated/developed

Table D.1. 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)
i) To develop of integrated farming technologies to maximize farm productivity and efficient use of resources	<p>Noakhali:</p> <p>Moveable seed bed: Early winter season HYV vegetables seedlings production</p> <p>Site specific cropping pattern: Three cropping patterns</p> <p>Existing CP1: Fallow-Fallow-T. Aman</p> <p>Improved CP1: Proso millet-G. Manure-T. Aman</p> <p>Existing CP2: Groundnut-Fallow- T. Aman</p> <p>Improved CP2: Groundnut-T. Aus-T. Aman</p> <p>Existing CP3: Soybean-Fallow-T. Aman</p> <p>Improved CP3: Soybean-T. Aus-T. Aman</p> <p>Patuakhali:</p> <p>Site specific cropping pattern: Two cropping patterns</p> <p>Existing CP1: Fallow-Mungbean-T. Aman</p> <p>Improved CP1: Potato-Mungbean-T. Aman</p> <p>Existing CP2: Grasspea-Fallow- T. Aman</p> <p>Improved CP2: Sunflower-T. Aus-T. Aman</p>	<p>Noakhali Site:</p> <p>Moveable seedbed:</p> <p>From 20 sq. feet (8'x5') seed bed GM is more than TK. 9000 within 32 to 35 day</p> <p>Improved CP1: WPREY increased 69%, Whole pattern GM increased 118%, MBCR is 2.31.</p> <p>Improved CP2: WPREY increased about 66%, whole pattern GM increased 64%, MBCR is 1.68.</p> <p>Improved CP3: WPREY increased about 72%, whole pattern GM increased 63%, MBCR is 1.65.</p> <p>Patuakhali Site:</p> <p>Improved CP1: WPREY increased 141%, Whole pattern GM increased 159%, MBCR is 2.59</p> <p>Improved CP2: WPREY increased about 139%, whole pattern GM increased 189%, MBCR is 2.13.</p>

Table D.2. Technology generated/developed by BRRRI 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)
Integrate component technologies under specific physical, biological and social environments by efficient use of resources for maximizing farm production	Improvement the productivity of <i>Gher</i> system	year-round pesticide-free vegetables from <i>Gher</i> dykes, high value fish production from <i>Ghers</i> , rice production	Improved production practices, use of pheromone traps, higher economic returns for high value fishes
	Duck-fish-vegetables culture in non-saline <i>Gher</i>	year-round pesticide-free vegetables from <i>Gher</i> dykes, eggs from Khaki Campbell ducks, high value fishes such as koi and shing from <i>Gher</i>	Proper management practices, use of pheromone traps instead of insecticide usage, use of duck faeces on <i>Gher</i> dykes' vegetables pits, higher economic returns for high value fishes

Table D.3. Technology generated/developed by BINA 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 maximize the farm productivity and efficient utilization of coastal areas	An improve cropping pattern for highland and medium high land in Shyamnagar- Mustard-Boro-T.Aman	In improved patterns whole pattern gross margin was higher (Tk.144182 /ha) compared to the existing cropping pattern (Tk.94297 /ha). The average marginal benefit cost ratio (MBCR) was found 1.91.	Income of farmers could be raised

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 at different FSRD sites of coastal ecosystems.	<p>Patuakhali: Modification of "Lebukhali Model"</p> <p>Five nieces were used instead of seven. Fence, Shady place, and Marshy Land were removed (not available)</p> <p>Nearby fallow space incorporated in the model that was used as Sorjan and raised bed system of vegetable production.</p> <p>Cropping pattern in open sunny place was also modified on the basis of farmers choice and nutrition.</p>	<p>Consumption, distribution and selling of vegetables increased about 41%, 0%, 53% for marginal farmer, 121%, 37%, 205% for small farmer and 100%, 40%, 136% for medium farmer respectively over before intervention.</p> <p>From Sorjan bed farmer could earn about TK.16000 during <i>Rabi</i> and <i>Kharif</i> season.</p> <p>From raised bed farmer could harvest 102 Kg, from which 29 Kg was consumed and 73 Kg was sold.</p>	Income & nutrition of farmers could be raised

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)
	<p>Noakhali: Modification of "Atkapalia Model"</p> <p>Previously six niches were used. At present nine niches were used.</p> <p>Partial replacement of leafy vegetables to HYV vegetables</p> <p>Introduction of elephant foot yam, bamboo, neem, drumstick, malta, naga chilli, year round chilli etc.</p>	<p>All groups of farmers consumed vegetable more than 60% and sold more than 22% of their total vegetables production.</p> <p>Av. cash income (vegetable and Fruits) :</p> <p>Marginal Farm-Tk. 2916 yr./family.</p> <p>Small Farm-Tk. 3998 yr./family.</p> <p>Medium Farm-Tk. 4320 yr./family.</p>	<p>More option for different categories of the farmers according to his/her existing resources framework.</p> <p>Adoption rate will be increased rapidly due to integration of HYV crops.</p>
	<p>Noakhali: Summer tomato production and early winter season vegetables production by utilizing the shade.</p>	<p>From one decimal of land farmers can earn about Tk. 4500 to Tk. 5000 from summer tomato production.</p> <p>Moreover, the shade could be used for the early winter vegetables (broccoli Cauliflower, cabbage) production. Farmers could be earned Tk. 4800 - Tk. 6000 from three decimal of land.</p> <p>In <i>Kharif</i> season: vegetables (bitter gourd, snake gourd, ribbed gourd) production could earn Tk. 4000 to Tk. 4500 from three decimal of land</p>	<p>Income and nutrition of farmers could be raised</p>
<p>ii) To modify/fine tune on-station technologies generated by NARS institutes at different FSRD sites of coastal ecosystems.</p>	<p>Patuakhali: Adaptation BRRi dhan48 during Kharif I season and BRRi dhan76 & BRRi dhan23 during <i>Kharif II</i> season instead of local rice varieties</p>	<p>BRRi dhan48 introduced in the site during Aus season. BRRi dhan76 and BRRi dhan23 varieties are also introduced in the site that increased rice yield 35% over local varieties.</p>	<p>Income of farmers could be raised</p>
	<p>Noakhali: Participatory variety selection for Aus season</p> <p>Seven entities- Hydra, BR26, BRRi dhan48, BRRi dhan82, BRRi dhan83, BRRi dhan85 and Binadhan-19</p>	<p>Binadhan-19 is suitable for medium high lands where drainage facility existing.</p> <p>BRRi dhan48 is not suitable for the lands where flooding depth exceed 0.8 meter.</p> <p>BRRi dhan85 is suitable for</p>	<p>More option for the farmers to choose variety based on their land types and climatic</p>

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)
		<p>both types of land.</p> <p>Farmers preferred BRR dhan83 due to its short duration, grain colour, and resistance to lodging.</p> <p>Within the cropping system transplanting system produced highest yield followed by dibbling (suitable for moderate saline soils)</p>	<p>conditions.</p> <p>Adoption rate might be increased due to short duration and higher yield variety was available.</p>
	<p>Noakhali: Land based T. Aman varieties production for cropping patterns</p> <p>Swarna, BR23, BRR dhan52, BRR dhan87</p>	<p>BRR dhan87 is suitable for slightly high land and suitable for watermelon based or groundnut based cropping pattern as the variety is short duration than other varieties.</p> <p>Farmers are used to cultivate Mamun Swarna which have lodging tendency during late rainy season.</p> <p>BRR dhan52 is suitable for medium high lands where water stagnant conditions prevail 10 to 15 days during late rainy season.</p> <p>BR23 is suitable for flooded lands where salinity raised during dry season</p>	<p>Farmers could be able to decide which types of variety he/she needed for his/her land.</p> <p>Easy to cope up improved cropping pattern according to land types.</p>
	<p>Noakhali: Intercropping system</p> <p>Cowpea with garlic</p> <p>Cowpea with sweet potato</p>	<p>Garlic+ Cowpea (3:1) and Sweet potato+ Cowpea (4:1) more productive than growing separately.</p> <p>Cowpea with garlic intercropping suitable for small-scale cultivation.</p> <p>Cowpea with sweet potato intercropping system possible in large scale in the coastal areas.</p>	<p>Household demand could be met up and additional income might be possible.</p>
<p>ii) To modify/fine tune on-station technologies generated by NARS institutes at</p>	<p>Noakhali: IPNS and IPM approaches for watermelon cultivation</p>	<p>By using IPNS and IPM approaches yield of watermelon was increased 12 to 16% over farmers practice and gross margin increased 40 to 81%.</p>	<p>Income of farmers could be raised</p>

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)
different FSRD sites of coastal ecosystems.	Noakhali: Quality seed production of Soybean in <i>Kharif II</i> season	The average yield was 1.63 t ha ⁻¹ where total variable cost was 41,523 Tk. ha ⁻¹ and average gross return was 1,20,977 Tk. ha ⁻¹ . Germination percentage was 19% higher than previous year Rabi season seeds.	Farmers could be able to cultivate lands with quality seeds and possible to sell additional amount at 67% higher than previous year seeds.
	Noakhali: Production program of green manuring crops	Assume that continuously cultivation in four or five seasons improves the permeability and helps to reclaim soil salinity	Salinity could be minimized and soil health improved.
	On-Farm verification trials 10 crops in Noakhali 07 crops in Patuakhali	Noakhali: Potato production with water hyacinth mulch is more profitable but this production system required large amount of water hyacinth. Therefore, should be small-scaled. BARI Soybean-6 better than Shohag and BARI Soybean-5 due to higher yield and economic return. GM of BARI Mung-6 & BARI Felon-1 much higher than local varieties. In moderate saline soils, BARI Surjomuki-2 and BARI Cheena-1 are more promising than BARI Sarisha -14 and BARI Kheshari-2 cultivation. BARI Gom-25 could be cultivated with supplementary irrigation.	Crops and variety could be selected for the improvement of existing cropping pattern. As a result, existing cropping pattern will be improved as well as total productivity and income could be increased.
Patuakhali: BARI Hybrid Maize-9 could be cultivated due to its higher yield.			

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)
		<p>BARI Chinabadam-8 gave second highest gross margin.</p> <p>BARI Mung-6 gave higher (Tk. 56000 ha⁻¹) gross margin compared to gross margin of BARI Felon-1.</p> <p>BARI Surjamukhi-2 variety should be promoted in large scale.</p> <p>BARI Morich-1 is more profitable compared to Grasspea and Mustard crops</p>	
<p>ii) To modify/fine tune on-station technologies generated by NARS institutes at different FSRD sites of coastal ecosystems.</p>	<p>Promotion of Power tiller operated seeder</p>	<p>BARI Soybean-6 sowing by PTOS sowing cost was reduced about Tk.2000 ha⁻¹ GM increased averagely 19% over farmers practices.</p> <p>BARI Mungbean-6 sowing by PTOS</p> <p>In Patuakhali, sowing cost reduced about Tk.8000 ha⁻¹ and av. 69% GM increased over traditional method. In Noakhali, sowing cost reduced minimum in, but 39% GM increased over traditional broadcasting method.</p> <p>Cowpea sowing by PTOS seed yield increased about 30%. In Patuakhali, Surjomukhi-2 sowing by PTOS. 40% yield increased compared to farmers practices. Additionally, 68% reduction in sowing cost was recorded.</p>	<p>Gross margin increased</p>
	<p>Mass vaccination of cattle, goat, chicken, duck and pigeon</p>	<p>Significantly reduced mortality rate</p>	<p>Survival rate of cattle, goat, chicken, duck and pigeon increased</p>

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)
	De-worming of cattle	Remarkable improvement of health and milk production of cow (22.22%)	Cattle health along with milk production may be increased
	Calf rearing at farmers house hold	Remarkable improvement of cattle health. Income also increased Tk. 37850 after 6 months per cattle.	Livestock production as well as income of farmers may be increased.
	Small scale pigeon rearing in farmer's household	Stock and squab consumption (25%) increased. Income also increased Tk. 1500 per month per farmer.	Income and family nutrition of farmers may be raised
	Sonali chicken rearing at farmers household	Stock and egg consumption increased. Income also increased Tk. 10860 per year per farmer.	Income and family nutrition of farmers may be raised
	Maximization of farmer's income through Monosex Tilapia/ Sorputi/ Shing monoculture.	Consumption and sell increased.	Income and family nutrition of farmers could be raised
	Spraying of mango and Jackfruit trees	44-50% production increased of jack fruit and mango	Income and family nutrition of farmers could be raised
	Rat control using metal plane sheet in coconut trees	Destruction of tender coconut decreased 85%.	Income and family nutrition of farmers could be raised
	Fodder Production	Increased fresh fodder for cattle	Cattle production will be increased
	Small scale vermicompost production	Major portion was utilized for vegetables production and small amount was sold.	Might be another income generating activity
	Off farm activities: Pati plant management	Through agronomic management and supplied of colour and design gross margin increased 235%	Income of women increased

Table E.2. Information/Knowledge generated/Policy generated by BRRI Component

General objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
Generate climate resilient and site-specific farming systems research and development technologies by optimizing land use for the coastal region of Bangladesh	<p>Improvement of existing Boro-Fallow-T. Aman cropping pattern</p> <p>CP1: Mustard-Boro-T. Aman CP2: Boro-Jute-T. Aman</p>	<p>Improved CP1: WPREY increased 38.26%, Whole pattern GM increased 48.94%, MBCR is 2.66.</p> <p>Improved CP2: WPREY increased 76.44%, Whole pattern GM increased 78.54%, MBCR is 2.11.</p>	<p>Productivity of system was increased and income as well.</p> <p>Fallow lands bring into cultivation</p>
	<p>Improvement of existing vegetables-rice cropping pattern. Three cropping patterns were followed-</p> <p>CP1: Khira+Turnip-T. Aman CP2: Broccoli+Pumpkin-T. Aman CP3: Khira+Turnip-T. Aus-T. Aman</p>	<p>Improved CP1: WPREY increased 114%, Whole pattern GM increased 116%, MBCR is 1.89.</p> <p>Improved CP2: WPREY increased 105%, Whole pattern GM increased 112%, MBCR is 1.99.</p> <p>Improved CP3: WPREY increased 110%, Whole pattern GM increased 127%, MBCR is 2.17</p>	<p>Newly introduced T. Aman variety (BRRI dhan75) create opportunity introduce more crop and produce more yield and income</p>
	<p>Development of alternate cropping patterns: Three cropping patterns were followed</p> <p>AC1: Khira+Pumpkin-Jute-T. Aman AC: 2Mustard-Mung bean-Jute-T. Aman AC3: Cabbage+Spinach-Boro-T. Aman</p>	<p>Alternat CP1: WPREY increased 205%, Whole pattern GM increased 224%, MBCR is 2.15.</p> <p>Alternat CP2: WPREY increased 64.3%, Whole pattern GM increased 68.09%, MBCR is 2.07.</p> <p>Alternat CP3: WPREY increased 147%, Whole pattern GM increased 152%, MBCR is 2.02</p>	<p>Increased cropping intensity.</p> <p>Productivity of system was increased and income as well.</p>

General objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
	Intercropping system: 1.Potato/Turnip/Sugarcane 2.Potato/Khira/Sugarcane	Potato/Turnip/Sugarcane: SEY increased 122% and GM increased 134%, MBCR is 2.01 Potato/Khira/Sugarcane: SEY increased 103% and GM increased 112%, MBCR is 2.00 More productive than growing sole sugar cane.	Total productivity and income could be achieved
Disseminate and fine tuning of farming systems and its component technologies to extrapolation domain	Year-round vegetables production in homestead area	Production, Consumption, Distribution and Selling of vegetables increased significantly.	Income and family nutrition of farmers could be raised
	Year-round vegetables production in nearby homestead area	Average production and gross margin were increased 213% and 282% after intervention with high value crops, variety and management practices.	Income and family nutrition of farmers could be raised
	Spice's (Ginger, Turmeric and <i>Chui jhal</i>) production in the shady places of homesteads	The average production (9.66t/ha and 21.90t/ha) and gross margin (Tk.77200 and Tk.617666) were found from ginger and turmeric, respectively.	Famers could be able to cultivate unutilized shady place of homestead and able to increased income.
	Production program of BRRI released T. Aman and Boro rice varieties in farmers' fields	Six T. Aman and Six Boro varieties were introduced at the FSRD site	Most of the newly introduced varieties were short duration, helping to increase the cropping intensity in farmers field

General objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
	Sonali chicken (layer) rearing under semi scavenging system	Average number of egg production, consumption and sale were found 816,183 and 583, respectively/yr./family. Average gross margin was found Tk. 4694 /yr./ family.	Income and family nutrition of farmers could be raised
	Turkey rearing under scavenging system	Consumption and sale increased. The average gross margin was Tk. 6390/yr./ family.	Income and family nutrition of farmers could be raised
	Rearing of Khaki Campbell duck in farmers house hold	The average number of eggs laid by duck was found 115/ month/ family. As well as gross margin was found Tk.921 /month/ farmer.	Income and family nutrition of farmers could be raised
	Goat rearing in farmers household	Average gross margin was increased Tk.3284. Average number of kids were born 2.2 per year/farmer	Increased goat production as well as family income.
	Fish polyculture in <i>Gher</i> system	After six month average production and gross margin were 6.40t/ha and Tk.537637 /ha . respectively. The total production and gross margin were increased 247% and 93.88% higher over before intervention. The intervention were, supplementary feed were supplied to the fishes at the rate of 3-5% of body weight. Growth and survival rate was normal.	Farmers are interested and they are able to apply the improved fish culture technologies in his <i>Gher</i> . Farmers income could be increased, culture of high value fishes in the <i>Gher</i> .
	Fish polyculture in mini pond	After six month average production and gross margin were 1.68 t ha ⁻¹ and Tk.112557 ha ⁻¹ , respectively. The total production and gross	Income and family nutrition of farmers could be raised

General objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
		<p>margin were increased 130% and 154% higher over before intervention.</p> <p>The intervention was, high value fishes and supplementary feed were supplied to the fishes at the rate of 3-5% of body weight. Growth and survival rate was normal.</p>	
	Establishment of homestead mini orchard along with crop production	Three mango orchards, one litchi and one jujube orchard were established. Different vegetables were produced while trees are growing	Better utilization of farm resources. Income and family nutrition of farmers could be raised
	Fruit tree plantation in homestead area	Different fruit trees were grown in homestead area	Increased nutritional balance and eliminate deforestation

Table E.3. Information/Knowledge generated/Policy generated by BINA 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 create awareness about modern Agricultural Technology (ies) among the participating farmers. (iii) To improve family income and livelihood	Improvement of the existing Boro-Fallow-T. Aman cropping pattern through inclusion of oil seed crops	In improved cropping patterns whole pattern gross margin was higher (Tk. 144182/ha) compared to the existing cropping pattern (Tk. 94297 /ha). The average marginal benefit cost ratio (MBCR) was found 1.91.	Increased production and income of the farmers
	Mass vaccination of cattle, goat, chicken, duck and pigeon	Decreased diseases and increased productivity	Survival rate of cattle, goat, chicken, duck and pigeon could be increased . More ever, increased production and income
	Small scale pigeon rearing in farmer's household	The squab production was 8-9 pairs/ year. Among them 20% consumed by farmer. The income from squab was Tk. 2167/months/family.	Income and family nutrition of farmers may be raised
	Maximization of farmer's income through carp poly culture technique at low-cost management in perennial pond	After six month average production and gross margin were 2.28t/ha and Tk.131581/ha. respectively. The total production and gross margin were increased 453% and 438% higher over before intervention. The intervention was, high value fishes and supplementary feed were supplied to the fishes at the rate of 3-5% of body weight. Growth and survival rate was normal	Income and family nutrition of farmers could be raised
	Empowerment of Rural woman through off-farm activities	Increase farm family income Tk.7820/year.	Income of women farmer 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)
	Turkey rearing under scavenging system	Consumption and sale increased. The average gross margin was Tk. 84638/yr./ family.	Income and family nutrition of farmers could be raised
	Rearing of Sonali chicken at Farmers' household	Consumption and sale increase. Average gross margin is increase Tk. 4819/yr./ family.	Income and family nutrition of farmers could be raised
	Year round vegetables production in homestead	Production, Consumption, Distribution and selling of vegetables increased about 207%, 44%, 276% and 536% respectively.	Income and family nutrition of farmers could be raised
	High value vegetable production at nearby homestead	Gross margin was increased 522% after intervention with high value crops, variety and management practices.	Income and family nutrition of farmers could be raised
	Production of modern Aman rice varieties	The gross margin was increased Tk.43490 ha ⁻¹ The Benefit Cost Ratio was found 1.8	Rice production and farmers income could be raised
	production of modern Mustard varieties	The gross margin was increased Tk. 33975 and Tk. 33 469 of Binasarisha-4 & 5, respectively Benefit Cost Ratio was found 1.94 & 1.93	Oil seeds production and farmers income could be increased
	production of grasspea varieties	The gross margin was increased Tk. 66110 ha ⁻¹ . Benefit Cost Ratio was found 3.75	Pulses production and farmers income could be increased
	Empowerment of rural woman through Off farm activities (vermicompost production)	Vermicompost production increased. Average production and gross margin are 2.19 t and Tk. 7820/yr./ family respectively.	Extra income of women

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
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.	-	-	
Journal publication	-	-	
Video documentry		1	

Table F.2. Materials Development/Publication made under the Sub-project by BARI Component

Publication	Number of publications		Remarks
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.	02	01	Will be published soon
Journal publication	01	-	Under Process
Video clip/TV program	01	02	Completed by the Co-PI and will be open YouTube channel
News Paper/Popular Article	-	07	-

Table F.3. Materials Development/Publication made under the Sub-project by BRRRI Component

Publication	Number of publications		Remarks (e.g., paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Leaflet		3	<ul style="list-style-type: none"> • ঘেঁরে সম্বন্ধিত ধান-মাছ-সবজি আবাদ • পারিবারিক স্বচ্ছলতায ছাগল পালন • বাড়ির আঙিনায় চুই বাল আবাদ
TV program	-	3	Mati o manush-BTV

Table F.4. Materials Development/Publication made under the Sub-project by BINA Component

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
TV program	-	1	1. TV programm “Mati and Manus” at Bangladesh Television (BTV)
Newspaper/Popular article 1. Online News paper		i.currentbarta.com (২২ সেপ্টেম্বর ২০১৯) ii. dailyalokitvor.com (২২ সেপ্টেম্বর ২০১৯) iii. patrodot.net (২২ সেপ্টেম্বর ২০১৯)	i. শ্যামনগরে মাছ চাষ সম্প্রসারণে মাঠ দিবস ii. শ্যামনগরে টমেটো চাষ ও পুকুরে/ঘেঁরে মাছ চাষ সম্প্রসারণে মাঠ দিবস iii. শ্যামনগরে টমেটো চাষ ও পুকুরে/ঘেঁরে মাছ চাষ সম্প্রসারণে মাঠ দিবস

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
TV program	-	1	1. TV programm “Mati and Manus” at Bangladesh Television (BTV)
2. News paper		<p>iv. dainikdristipat.com (১১ মার্চ ২০২১)</p> <p>v. shobdokotha24.com (১১ মার্চ ২০২১)</p> <p>i. মানজমিন (০৮ মার্চ ২০২০)</p> <p>ii. দৈনিক ইত্তেফাক (২৭ জানুয়ারি ২০২১)</p> <p>iii. দৈনিক কালের চিত্র (১৮ সেপ্টেম্বর ২০২০)</p> <p>iv) যায়যায়দিন</p>	<p>iv. শ্যামনগরে বসতবাড়িতে সারাবছর সবজি চাষ জনপ্রিয়করণ ও সম্প্রসারণের লক্ষ্যে মাঠ দিবস</p> <p>v. শ্যামনগরে সবজি চাষ জনপ্রিয়করণ ও সম্প্রসারণের লক্ষ্যে মাঠ দিবস</p> <p>i. উপকূলীয় অঞ্চলের জনগোষ্ঠীর জীবন যাত্রার মান উন্নয়নে খামার ব্যবস্থাপনা শীর্ষক প্রশিক্ষণ কর্মশালা</p> <p>ii. ঘেরের আইলে টমেটো চাষ সম্প্রসারণের লক্ষ্যে মাঠ দিবস</p> <p>iii. কাশিমারিতে কৃষকদের মাঝে গাছের চারা বিতরণ</p> <p>iv) বিনাখেসারী-১ চাষ সম্প্রসারণের লক্ষ্যে মাঠ দিবস</p>

G. Description of generated Technology/Knowledge/Policy:

i. Technology Fact Sheet

Fact sheet-1

Title of the technology: Year-round vegetables production in Modified Lebukhali (Jamla) model

Introduction: The coastal agriculture is controlled primarily by deposition of water in land surface due to monsoon rain and tidal intrusion. If deposition is higher and recession is late, it will limit diversity of *Rabi* cropping specially vegetable. On the other hand deposition of excessive water in land during monsoon shutdown the way of *Kharif* vegetable cultivation. That's why Coastal regions are mostly vegetable deficient area. Another reason of shortage production of vegetables in coastal region is land type. Most of the land of the region is medium high to medium low where late local tall varieties of T.aman rice are cultivated. Due to late harvest of these varieties the optimum sowing time of winter vegetables passed away. Late planted vegetable has to face water scarcity as well as salinity in the growing stage that reduce yield and farmers do not get good market price. For these reason farmers become dishearten and do not show their interest to cultivate vegetable next year. In these situations, vegetable production in homestead is an appropriate technique in both *robi* and *kharif* season. During 2001 'Labukhali Model' was developed to produce vegetables round the year for coastal region but with time it needs to modification as homestead ecology and farmers choice has been changed. So, on the basis of research result during 2018-2020 at Farming System Research Site, Jamla, Dumki, Patuakhali some modification has been done and renamed as Modified Lebukhali model or Jamla Model.

Description: In modified Ledukhali model only five niches were used instead of previous seven. Fence, Shady place and Marshy Land niches were removed as now they are not available in the homestead of coastal region. A new niche, nearby fallow space, incorporated in the model that was used as sorjan system of vegetable production. Detailed modified Lebukhali Model are presented in Table G. 1.

Table G.1. Modified Lebukhali Model or Jamla Model

Niche/space		Year round homestead vegetable pattern		
		<i>Rabi</i>	<i>Kharif I</i>	<i>Kharif II</i>
Open sunny space	Bed-1	Tomato + Spinach	Indian Spinach	
	Bed-2	Brinjal + Red Amaranth	Kangkong	
	Bed-3	Nolkhol + Coriander leaf	Stem Amaranth	Okra
	Bed-4	Cauliflower + Spinach	Okra	Red Amaranth
	Bed-5	Radish + Red Amaranth	Stem Amaranth	Red Amaranth
Trellis		-	-	Ribbed gourd /Snake gourd
Non-fruit trees		-	Sponge gourd/Yam	Sponge gourd/Yam
Pond/ditch slope		Bottle gourd/Sweet gourd	Bitter gourd	
Nearby fallow place		Tomato+ Red Amaranth	Bottle gourd + Yard long bean	

In nearby fallow place alternate rows of ridges and furrows (Sorjan) were constructed depending on farmers existing lands. Size of the beds was varied according to available fallow space and the level of monsoon flooding. The beds were high enough, so that the crops were not flooded during monsoon. Year-round cultivation of vegetables was normally grown on the high beds as well as on their slopes. Selection of crops depends on the size of Sorjan, farmer's preference and demand of the local market.

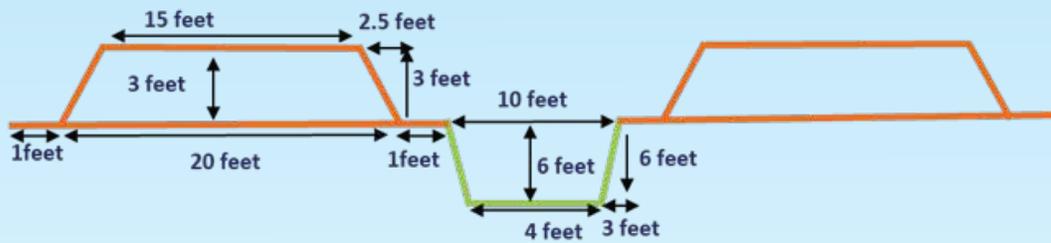


Figure G. 1. Bed diagram of Sorjan for nearby fallow land

Suitable location/ecosystem: The technology is suitable for coastal ecosystem in both saline and non saline land of AEZ-13 and AEZ-18.

Benefits: Availability of vegetable will be increased round the year. A farmer having a homestead with five niches i.e., 12x12 feet open sunny place, trellies, nonfruit trees, pond slope and fallow land nearby homestead will be able to produce about 375 kg vegetables round the year. That will help the coastal people to balance their nutrition censuring fresh and save vegetables.

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Fact sheet-2

Title of the technology: Development of Sunflower-T. Aus-T. aman cropping pattern over grasspea -Fallow-T. Aman pattern

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. Cropping intensity in southern region is very low less than national average 192%. The major cropping pattern is single T.aman and T. Aman/grasspea-Fallow. There is scope of increasing cropping intensity in the southern region by the improvement of present cropping pattern. One of the option may be incorporating Sunflower and T.Aus in the existing rice based cropping pattern. In order to produce more food in the southern region two most important options to be adopted are i) to increase the cropping intensity producing two 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. One of the dominant existing cropping patterns of Patuakhali is Grass pea – fallow -T. aman rice (local variety). The cultivation of low yielding varieties of Grass pea and rice crops results in lower productivity of the pattern. Farmers relayed Grass pea with local variety in T. Aman field. Most of the year Grass pea become destroys due untimed rainfall at germination or early growth stage. As a result, farmers did not get expected yield. So, 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 Sunflower and rice crop by NARS institutes have created good opportunities to improve existing Grasspea - Fallow -T.Aman rice. Considering farmers' choice, land and soil suitability of crops the present study was undertaken to evaluate the feasibility of growing new varieties of Sunflower, T. Aus and T. Aman rice crops in existing Grasspea – Fallow -T. Aman rice cropping pattern aiming to developed cropping pattern and thereby raising total productivity and farmers income.

Description: In this cropping pattern three crops viz., Sunflower and two rice crops are included. Dry land preparation is required for the establishment of upland crop. 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 Sunflower and T. Aus rice. The main field duration of the three crops is about 310-320 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 should be released about seven days before the establishment of succeeding 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-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 Sunflower: The land is prepared by power tiller for Sunflower. After well preparation of land the seeds of Sunflower are sown at field capacity of soil moisture on 1st week of January. All the fertilizers are applied as basal fertilizer except half of the urea. Basal fertilizers are applied @ 90-30-75-30-5-5 kg ha⁻¹ N-P-K-S-Zn-B. The Sunflower variety is BARI Surjomukhi-2. Seed of Sunflower is usually sown in line (50×25 cm) @ 13 kg ha⁻¹. Half of the urea split in two, first top dressed at 20-25 and second top dressed 40-45 days after sowing. 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 if Sunflower is damage by parrot. Sunflower is harvested within third week of April.

Cultivation procedure of T. Aus and T. Aman rice: After the harvesting of Sunflower, the land is

prepared by power tiller with irrigation and puddling for transplanting of T. Aus 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 @ 70-18-36-10-10 ha⁻¹ N-P-K-S-Zn-B for T. Aus and @ 90-20-45-10-10 kg ha⁻¹ N-P-K-S-Zn for T. Aman rice. Twenty five days-old seedlings of T. Aus and Thirty days old seedlings of T. Aman rice are transplanted in the First week of June and second week of September. Two times hand weeding is done following the urea top dressing. T. Aus rice variety BRRI dhan48 and T. Aman rice variety BRRI dhan52 is used in this technology. Seedling spacing is 20cm x 15 cm and 25cm x 15 cm for T. Aus and T. Aman, respectively. Numbers of seedlings are 2-3 seedlings per hill. Curative measures are taken against pest and diseases. T. Aus rice is harvested at the last week of September and T. Aman rice is harvested in the last week of December.

Suitable location/ecosystem: The technology is suitable in the medium highland of AEZ-13, 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 13.93 t ha⁻¹yr⁻¹ whereas the existing pattern demonstrates 6.9 t ha⁻¹yr⁻¹. This was 151% more Rice equivalent yield (RYE) over existing patterns that increased gross margin Tk. 125727 over existing cropping pattern (Tk. 45130).

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Fact sheet-3

Title of the technology: Development of Potato-Mungbean-T. Aman cropping pattern over Fallow-Mungbean -T.Aman pattern

Introduction: Bangladesh is a densely populated country of the world (Worldmeter, 2021). 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. Cropping intensity in southern region is very low less than national average 192%. The major cropping pattern is single T. Aman , Fallow -Mungbean - T. Aman and T. Aman/grasspea-Fallow. There is scope of increasing cropping intensity in the southern region by the improvement of present cropping pattern. One of the options may be incorporating potato in the existing rice based cropping pattern. In order to produce more food in the southern region two most important options to be adopted are i) to increase the cropping intensity producing two 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.

Description: In this cropping pattern, three crops viz., Potato, Mungbean, and T. Aman is cultivated. Land preparation is required for individual crop. For Potato and Mungbean, the lands are prepared at the field 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. Aman crops is required for quick root development. Here stagnant water is accumulated either from rainfall and soil is puddled and rice seedlings are transplanted. In this cropping pattern 3 crops are cultivated in sequence starting from *Rabi* season with Potato followed by Mungbean, and T. Aman. The field duration of the three crops is about 270-280 days. So, careful attention was given to timely establishment of crops. 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. As potato lands were dried and semi ploughed so turned around time was only 2-3 days. After optimum land preparation, Potato tuber is sown in furrow at field capacity of soil moisture at First week of March. Fertilizers are applied @ 150-45-110-16-2.8-1 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-73. Potato tuber is usually sown in line with a spacing of 60 cm×25 cm @ 1.8 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 last week of February.

Cultivation procedure of Mungbean: After the harvest of Potato, land is prepared by power tiller for Mungbean cultivation. Mungbean is sown at 1st week of March. After mungbean sowing a light irrigation was applied to germinate seeds properly. Fertilizers are applied @ 22-28-22-10-1.8-1 kg ha⁻¹ of N-P-K-S-Zn-B kg ha⁻¹ respectively. All fertilizers are applied during final land preparation. The Mungbean variety is BARI Mung-6. Mungbean is broadcasted @ 40 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. Aman: After the harvest of Mungbean, the land is irrigated and puddled by power tiller for T. Aman transplanting. Fertilizers are applied @ 80-28-45-11-3.5-1 kg ha⁻¹ of N-P-K-S-Zn-B kg ha⁻¹, 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 dhan52. Seedlings are transplanted at 20 x 20 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 T.Aman rice is infested by pest and diseases. T. Aman is harvested at 2nd week of December.

Suitable location/ecosystem: The technology is suitable in the medium highland of AEZ-13, 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 of the alternate cropping pattern is 18.97 t ha⁻¹. The gross margin is 159% higher than the existing Fallow- Mungbean -T.Aman pattern cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 2.59.

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Fact sheet-4

Title of the technology: Improvement of the existing Groundnut (Dhaka-1)-Fallow-T. Aman (Sharwna) cropping pattern through inclusion of T. Aus & short duration T. Aman variety

Introduction: In Bangladesh availability of sufficient food for current and future generations is critical and must be based on sustainable methods of production. At present total cultivable land is 8.59 million hectares which is decreasing at the rate of about 0.73% per year. Cropping intensity in southern region is very low less than national average 192%. In order to produce more food in the southern region of Noakhali, two most important options to be adopted are i) to increase the cropping intensity producing two 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. One of the dominant existing cropping patterns of Noakhali is Groundnut – Fallow -T.aman (local variety). There is scope of increasing cropping intensity of the existing cropping Groundnut – Fallow -T. Aman (local variety) through incorporating short duration high yielding T. Aus and T. Aman in the existing cropping pattern. Recently NARS institutes BIRRI and BINA has development short duration high yielding varieties of T. Aus and T.aman crop have created good opportunities to improve existing Groundnut – Fallow -T. Aman (local variety). Considering farmers' choice, land and soil suitability of crops the present study was undertaken to evaluate the feasibility of growing new varieties of T. Aus and T. Aman rice crops in existing Groundnut – Fallow -T. Aman (local variety) cropping pattern. This could be achieved through inclusion of crops within the cropping pattern in such a way that time of sowing of one crop will not be hampered by other crops and the whole pattern achieved higher gross margin over existing cropping pattern.

Description: In this cropping pattern three crops viz., Groundnut and two rice crops are included. Dry land preparation is required for the establishment of upland crop. The dry lands are prepared at the field capacity (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 Groundnut followed by T. Aus rice and T. Aman rice. The main field duration of the three crops is about 290 -300 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 should be released about seven days before the establishment of succeeding 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-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 Groundnut: The land is prepared by power tiller for groundnut. After well preparation of land the seeds of groundnut are sown at field capacity of soil moisture on 3rd to last week of December. All the fertilizers are applied as basal fertilizer except half of the urea. Basal fertilizers are applied @ 12-32-42-54-0-2 kg ha⁻¹ N-P-K-S-Zn-B. The groundnut variety is Dhaka-1. Seed of ground nut is usually sown in line (30cm×15 cm) @ 110 kg ha⁻¹. Half of the urea top dressed 40-45days after sowing at flower initiation stage. 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 if ground nut is damage by pest and diseases. Ground nut is harvested within first to second week of April.

Cultivation procedure of T. Aus and T. Aman rice: After the harvesting of groundnut, the land is prepared by power tiller with irrigation and puddling for transplanting of T. aus 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 @ 69-11-38-7-1.9-0 ha⁻¹ N-P-K-S-Zn-B for T. Aus and @ 69-22-24-5-4-0 kg ha⁻¹ N-P-K-S-Zn for T. Aman rice. Twenty five days-old seedlings of T. Aus and thirty days old seedlings of T. Aman rice are transplanted in the third week of May and third week of August. Two times hand weeding is done following the urea top dressing. T. Aus rice variety Binadhan-19 and T. Aman rice variety BRRI dhan87 is used in this technology. Seedling spacing is 20 cm x 15 cm and 25 cm x 15 cm for T. Aus and T. Aman respectively. Numbers of seedlings are 2-3 seedlings per hill. Curative measures are taken against pest and diseases. T. Aus rice is harvested at the second week of August and T. Aman rice is harvested in the last week of November.

Suitable location/ecosystem: The technology is suitable in the medium highland of AEZ-18 (Young Meghna Estuarine flood plain). This type of cropping pattern is suitable for the lands which located near channel or slightly higher than medium high land and where irrigation facilities prevail. The technology can also be followed in the other medium high lands of extrapolation areas having similar soil and climatic environment. Additionally, heavy rainfall during late December and early January is completely unfavorable to fit this improved cropping pattern in such locality.

Benefits: Rice equivalent yield (REY) of improved cropping pattern is 12.48 t ha⁻¹ yr⁻¹ whereas the existing pattern demonstrates 7.54 t ha⁻¹ yr⁻¹. This was 65.51% more Rice equivalent yield (RYE) over existing patterns that increased gross margin Tk. 102157 over existing cropping pattern Tk. 62218. The marginal benefit cost ratio (MBCR) was found 1.68 which indicated the superiority of the three crops pattern over farmers' two crops cropping pattern.

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Fact sheet-5

Title of the technology: Improvement of the existing Soybean (Shohag)-Fallow-T. Aman (local) cropping pattern through inclusion of modern soybean varieties and Aus rice

Introduction: In Bangladesh availability of sufficient food for current and future generations is critical and must be based on sustainable methods of production. At present total cultivable land is 8.59 million hectares which is decreasing at the rate of about 0.73% per year. Cropping intensity in southern region is very low less than national average 192%. In order to produce more food in the southern region of Noakhali, two most important options to be adopted are i) to increase the cropping intensity producing two 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.

Soybean is the main cash crop in greater Noakhali district where after harvesting of soybean the lands remain fallow until *Kharif II* season rice crop cultivation. Under such situation, there is an option to inclusion of one crop in such types of cropping pattern. Moreover, farmers of this region mainly cultivated Shohag variety which was released in 1992 by BARI. Afterwards, three high yielding varieties were developed and need to be examined under different cropping patterns to generate extension message as well as replacing the traditional variety by the modern variety.

One of the dominant existing cropping patterns of Noakhali is Soybean (Shohag) – Fallow -T. Aman. There is scope of increasing cropping intensity of the existing cropping Soybean (Shohag) – Fallow -T. Aman (local variety) through incorporating of high yielding Soybean and short duration T. Aus and T. Aman in the existing cropping pattern. Recently BARI has developed high yielding varieties of soybean and BRRI has developed short duration high yielding varieties of T. Aus and T. Aman which have created good opportunities to improve existing Soybean (Shohag) – Fallow -T. Aman. Considering farmers' choice, land and soil suitability of crops the present study was undertaken to evaluate the feasibility of growing new varieties of soybean, T. Aus and T. Aman rice crops in existing Soybean (Shohag) – Fallow -T. Aman cropping pattern. This could be achieved through inclusion of crops within the cropping pattern in such a way that time of sowing of one crop will not be hampered by other crops and the whole pattern achieved higher gross margin over existing cropping pattern.

Description: In this cropping pattern three crops viz., Soybean and two rice crops are included. Dry land preparation is required for the establishment of upland crop. The dry lands are prepared at the field capacity (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 Soybean followed by T. Aus rice and T. Aman rice. The main field duration of the three crops is about 300 -305 days. So careful attention was given to timely establishment of crops. To increase the turnaround time the crops were harvested at physiological maturity rather than harvesting maturity. Fields should be released about seven days before the establishment of succeeding 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-based fertilizer dose was considered (BARC, 2018) rather than 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 Soybean: The land is prepared by power tiller for groundnut. After well preparation of land the seeds of soybean are sown at field capacity of soil moisture on second to third week of December. All the fertilizers are applied as basal. Basal fertilizers are applied @ 12-20-22-5-24-1.3 kg ha⁻¹ N-P-K-S-Zn-B. The Soybean variety is BARI Soybean-6. Seed of soybean is usually sown in line (25

cm×2 cm) @ 45 kg ha⁻¹. Thinning and weeding were done as and when necessary. One or two irrigations are required and are applied as and when necessary. Curative measures are taken if soybean is damaged by pest and diseases. Soybean is harvested within first of May.

Cultivation procedure of T. Aus and T. Aman rice: After the harvesting of soybean, the land is prepared by power tiller with irrigation and puddling for transplanting of T. Aus 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 @ 69-11-38-7-1.9-0 ha⁻¹ N-P-K-S-Zn-B for T. Aus and @ 69-22-24-5-4-0 kg ha⁻¹ N-P-K-S-Zn for T. Aman rice. Twenty five days-old seedlings of T. Aus and thirty days old seedlings of T. Aman rice are transplanted in the third week of May and last week of August. Two times hand weeding is done following the urea top dressing. T. Aus rice variety BRRI dhan85 and T. Aman rice variety BRRI dhan52 is used in this technology. Seedling spacing is 20 cm x 15 cm and 25 cm x 15 cm for T. Aus and T. Aman respectively. Numbers of seedlings are 2-3 seedlings per hill. Curative measures are taken against pest and diseases. T. Aus rice is harvested at the second week of August and T. Aman rice is harvested in the second week of November.

Suitable location/ecosystem: The technology is suitable in the medium highland of AEZ-18 (Young Meghna Estuarine flood plain). This type of cropping pattern is suitable for the lands which located near canal or slightly higher than medium high land and where irrigation facilities prevail. The technology can also be followed in the other medium high lands of extrapolation areas having similar soil and climatic environment. Additionally, heavy rainfall during late December and early January is completely unfavorable to fit this improved cropping pattern in such locality.

Benefits: In improved pattern, T. Aus (BRRI dhan85) produced grain yield of 3.93 t ha⁻¹ and BARI Soybean-6 produced 31% more yield over existing Shohag variety. Moreover, replacing of soybean variety in Rabi season and inclusion of T. Aus in *Kharif I* season in the existing cropping pattern increased rice equivalent yield (REY) by 71% compared to farmers' existing cropping pattern. The marginal benefit cost ratio (MBCR) was found 1.65 which indicated the superiority of the three crops pattern over farmers' two crops cropping pattern.

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Fact sheet-6

Title of the technology: Movable seedbed for early winter season high value vegetables seedlings production at medium high land to lowlands adjacent to homestead

Introduction: After intervention of the project, probably farmers have been more intending to cultivate vegetables on their high lands or modified land adjacent to homestead than ever before. Meanwhile, lack of early seedlings and supply of quality seedlings had proven as the major constraints for winter vegetables production in the coastal saline areas of Noakhali during defining recommendation domain. In addition, farmers incapacitated to install permanent structure for seedlings production due to versatile uses of accessible small-scaled high lands, land ownership pattern diversifying (sharecropper or tenant farmers), delaying cessation of the monsoonal rainfall and water stagnancy during late *Kharif II* season. Such ecosystem, often called for contemporaneous kind of seedlings production unit that should be portable or moveable. Afterwards, the Co-PI of Noakhali site with close supervision of the PI has developed a seedbed. Finally, it was established as demonstration at field conditions by the Co-PI during last week of September 2019 which was replicated in the following year. In this year (2020), two seedbeds were established and compared with the traditional seedbeds used elsewhere at Subarnachar upazilla. Initially last year, only tomato seedlings were produced in such type of seedbed whereas four types of crops such as cabbage, cauliflower, broccoli, and tomato were selected for seedlings production. Moreover, cabbage and cauliflower seedlings were established in first seedbed during last week of September 2020 and total amount of seeds required were 35 gm (Cabbage-20 g and Cauliflower-15 g). In case of second seedbed, cauliflower (10 g), broccoli (20 g) and tomato (6 g) were used to produce seedlings during 04 October 2020. The quality seedlings were distributed among the cooperative and non-cooperative farmers during field day organized under the support of the project.

Description: The description of the movable or potable seedbed was given below:

Table G.2. Description of movable seedbed established at medium high land adjacent to homestead areas in FSRD site, Subarnachar, Noakhali during late Kharif II to early Rabi season.

Name of the materials used	Description of the seedbed
<ul style="list-style-type: none"> • Bamboo (27 feet long and 2 pcs) • Muli bamboo (9 feet long and 6 pcs) • Net (5 feet width and 10 feet long with 4"X4" mash) • Polythen (5 feet width and 10 feet long and 80 to 100 mm) • Rope, Nail etc. • Vermicompost (20 kg) • Coco dust (80 kg) • Straw (50 kg) • Jute bag • Fungicide (Provax 200 WP) • Seeds (Respected crops) • Insecticides (for sucking types of insects) • Root promoting hormone (Rooton) 	<p>The seedbed was established in a sunny place where north-south opened alignment was used to minimizing shade and for keeping cool from extra heating through better air circulation. It was four (05) feet wide and eight (8) feet long. Initially, four-bamboo lath (5.5 feet long) was installed in the outer four side of the measured seedbed. Then, the two bamboo laths (six feet) were installed in such a way that each bamboo lath (six feet) was arrayed in the middle position of the two-bamboo lath (5.5 feet) in breadth direction. Also, the lower part of all bamboo laths was buried (0.5 feet) at below the ground. Afterwards, three light bamboo laths (9 feet) were used to keep the structure strong and rigid. In this case, upper ends of two bamboo laths (5.5 feet long) were tied up together by rope with both ends of each nine feet long bamboo lath for connected one-another. Similarly, other bamboo laths (two 5.5 feet and two 6 feet) were tied up with rest of the two nine feet long bamboo laths. Finally, boat-roof shaped roof was prepared where net (5 feet width and 10 feet long with 4"X4" mash) was tied up together with all possible place of the roof by rope. Afterwards, a flat base was prepared (above 2 feet from the ground level) by splitting portion of the bamboo. The distance of the flat base from roof was 3 feet from the corner and 3.5 feet from the middle of roof. Preparation of seedbed media was given below-</p> <ul style="list-style-type: none"> • Composed or wet straw was placed just above the flat base with 2-inch height layer. • Afterwards, composed coco-dust was mixed with vermicompost thoroughly and major portion (80 Kg) of this mixture was broadcasted all over the straw layer randomly with the help of the hand. The mixture layer was kept 4 to 5 inch in height and the surface was leveled by the piece of flat wood (8 inch long and 6 inches wide). • Then, Provex 200 WP (2 gm per liter water) was applied for controlling soil borne diseases and after two days root promoting hormone (Rooton @ 100 gm) was broadcasted. • At last, seeds (treated by Provax 200 WP) were sowed in solid line where rows (row-to-row distance two inch) were oriented in north-south direction.

Table G.3. Economic return from Movable seedbed established at selected farmer field of FSRD site, Subarnachar Upazila, Noakhali during late Kharif II season of 2019 and 2020

Sl. No.	Expenditure items	TVC (TK.)	Marketable Seedling (No.)	GR (TK.)	GM (TK.)
1	Bamboo (30' long 2 pcs @ 250/-)	500/-	<ul style="list-style-type: none"> •Cabbage-2267pcs •Cauliflower-2345 pcs •Broccoli-2310 pcs •Tomato-247 pcs 	13081/-	9622/-
2	Muli bamboo (15 feet long and 13 pcs @ 27/-)	351/-			
3	Net (6 feet width and 10 feet long with 4"X4" mash-250 gm)	45/-			
4	Polythene cover (6 feet width and 10 feet long and 80/100 mm @ 25/- Yard) -3.5 Yard	88/-			
	Polythene (6 feet width and 8 feet long and 50/60 mm @ 20/- Yard)-3Yard	60/-			
5	Rope (250 gm), ganny cover (6 feet width and 9 feet long)	150/-			
6	Seeds of cabbage (10 gm), cauliflower (10 gm), broccoli (10 gm) and tomato (2 gm)	1165/-			
7	Vermicompost (20 kg), Straw (50 kg), Coco dust, Fertilizers, Fungicide etc.	600/-			
8	Labour (1 person)	500/-			
Total cost		3459/-	7169 pcs		

*Price of seedling (pcs per TK.): 2 Tk. per pcs of Cauliflower, Broccoli, and Tomato, 1.5 Tk. per pcs of Cabbage

*GR=Gross Return, TVC=Total Variable Cost, GM=Gross Margin

Suitable location/ecosystem: The technology is suitable for coastal areas where early winter season vegetables seedlings production could not possible in traditional way especially waterlogged conditions prevailed during late rainy season.

Benefits: Only 20 sq. feet area was needed to produce more than 7000 seedlings and one can earn more than Tk. 9000 from it. Total duration of the seedbed varied from 32 to 35 days. Afterwards, all the materials could be reused for pit preparation as well as organic matter enrichment.

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Fact sheet-7

Title of the technology: Integrated Rice-Fish-Vegetables Cultivation in Gher System

Introduction:

- Year round production ensured and increased through integrated Gher cultivation system in south-western region of Bangladesh
- T. Aman or Boro rice could be cultivated based on the existing salinity level of the respective Gher
- Fish polyculture ensured proper utilization of different tier of water resources in Gher
- Safe vegetables could be grown on the Gher dykes round the year
- Integrated Gher cultivation system ensured to maximized the land productivity
- Integrated cultivation system reduces the pesticide and fertilizer costs
- Productivity of land area increases and farmers can generate higher income

Description:

G4. Brief description of integrated rice-fish-vegetables cultivation technology

Item	T. Aman	Boro
Rice cultivation		
Variety	BR10, BRRI dhan30, BRRI dhan49	BRRI dhan28, BRRI dhan58, BRRI dhan67
Spacing (cm×cm)	25×15	20×20
Seeding/Transplanting time	July-August	January
Seedling age (days)	25-35	25-40
Fertilizer dose (Kg/ha.)		
Urea	80-90	130-150
DAP	60	90
MoP	105	150
Gypsum	68	112
Zinc sulphate	-	11
Fertilizer application	All of fertilizer, DAP, MoP, Gypsum and Zinc sulphate should be applied during final land preparation. During rice cultivation, application of urea has to be reduced to half of approved rate or less depend on crop condition. Urea has to be applied in two or three instalments based on the condition of standing rice crop.	

Item	T. Aman	Boro
Rice cultivation		
Intercultural operation	<p>In integrated rice-fish cultivation system, fish fingerlings are released in March-May. Water depth has to be cut down during Aman rice transplanting. Water level has to be risen up after 15-25 days of rice transplanting so that easy entrance be open for fish to the rice field.</p> <p>Boro rice cultivation be done as usual after drain out the excess water followed by fish harvesting. Some fishes be allowed to grow in the surrounding canal of the Gher.</p> <p>Boro rice is cultivated instead of T. Aman in all the gher where there is no facility to remove excess water in monsoon and only fish is cultivated during Aman season.</p>	
Irrigation	<p>No irrigation is needed during T. Aman cultivation while during Boro rice cultivation, irrigation is done as per requirement. If the gher has no salinity problem, alternate wetting and drying (AWD) procedure can be followed for irrigation.</p>	
Pest and disease management	<p>If the pest infestation spread out at economic threshold level (ETL), only then recommended pesticide has to be applied in the rice field. If the applicable pesticide is harmful to fish, then it is better to reducing the water level in gher to transfer fishes into the canal. However, due to the management of integrated rice-fish cultivation system, the infestation of weeds and disease-insect is much less.</p>	
Harvesting	December-January	April

Vegetables cultivation:

Item	Kharif	Rabi
Vegetables name	Pumpkin, Bottle gourd, Sponge gourd, Bitter gourd, Yard long bean Ladies finger, Brinjal and Indian spinach	Pumpkin, Bottle gourd, Country beans, Tomato, Turnip, Brinjal
Spacing (cm×cm)	Required distance for seeding/transplanting of respective vegetables has to be maintained as per recommendation	
Seeding/Transplanting time	Kharif-1: March-April Kharif-2: July-September	November-December
Fertilizer dose (Kg/ha) and application	Urea, DAP, MoP, Gypsum, Zinc and Boron fertilizer has to be applied on the basis of requirements as well as recommended management practices could be followed for each crop	

Item	Kharif	Rabi
Intercultural operation	Weeding has to be done regularly for vegetables cultivation. Trellis has to be set up as per requirement of the crop.	
Irrigation	Irrigation has to be done every 10-15 days interval for Rabi crop. However no irrigation is needed for Kharif crop cultivation.	
Pest management	Mostly insect and disease infestation can be controlled by pheromone traps or mechanical method. If infestation level reach at ETL, only then recommended pesticide has to be applied.	
Harvesting	Vegetable crops could be collected throughout the year according to the duration of each crop.	

Fish cultivation:

Subject	Management
Weight and size of stocked fingerlings	Overwintered carp fingerlings are better for cultivating in Ghers. Early harvesting and marketing can be done, if the stocked fingerlings weight are around 100-150 g.
Stocking period	March-May
Stocking density (number/decimal)	Silver carp: 6-7, Catla: 4-5, Rohu: 5-6, Mrigal: 6-7, Thai puti: 3, Common carp: 3, Grass carp: 2 has to be stocked in gher. On the basis of existing salinity level, Faissa (Parshe) and Khorkhullu: 3-6 each, Seabasses (Coral/Bhetki): 3 -4 can be stocked in the ghers. Tilapia fries: 25-30 has to be stocked for feeding purpose of Seabasses.
Fertilizer application	Manure: 500 kg, Fermented mustard oil cake: 300 kg, Urea: 75 kg, TSP: 40 kg, MoP: 40 kg has to be applied per hectare 7-10 days prior to starting fish cultivation.
Feeding management	Fishes can be fed with farm made or commercial feed. Fishes has to be fed at 2-3% of the body weight. Urea and TSP has to be applied regularly at 50 g/dec./week to maintain natural food for fishes in ghers.
Disease management	Very few diseases occur if the fishes are stocked at optimum density level. Sometimes lice infestation and dropsy can occur in gher culture. In these cases, approved rates of recommended antibiotics have to be applied with feed.

Subject	Management
Fish Harvesting	Usually fish harvesting and marketing can be done during November to February. However, partial harvesting and marketing can be started from September. Complete harvesting has to be done after drying of ghers during December-January. Grass Carp, Common Carp, Silver Carp, Faissa/Parshe and Khorkhullu fishes reached of marketable size after six months. If Boro rice is cultivated, fishing has to be completed in January.

Suitable location/ecosystem:

Ganges Tidal Floodplain (AEZ 13), Area: Low to medium saline Ghers of the south-western region of Bangladesh

Benefits:

Total Income: Tk.11,15,000 ha⁻¹

Total Expenditure: Tk. 5,59,500 ha⁻¹

Total Benefit: Tk.5,55,500 ha⁻¹

Integrated farming of rice-fish-vegetables in Ghers ensured farmers' food security.

The total productivity of Gher system can be increased through proper utilization of existing resources in lower intensive productive area of coastal region of Bangladesh.

Pesticide less or lower amount of pesticides is needed to cultivate rice and vegetables which can play a vital role for producing safe crops in this Gher production system.



Picture G.1. Integrated Rice-Fish-Vegetables Cultivation in Gher System

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Fact sheet-8

Title of the technology: Integrated duck-fish-vegetables culture in Gher system

Introduction: Since the birth of Bangladesh, unbalanced development efforts towards the agricultural sector without appropriate concerns for the environment and declining productivity levels of the resource bases have led to unprecedented crises in agriculturally based economy. 'Gher' farming is a unique system that can unite three enterprises and shift balance to the agricultural developmental efforts of the coastal region of Bangladesh.

Description: Gher farming system in Kaliganj, Satkhira is mainly done on the basis of salinity ranges in Gher. In case of, integrated duck-fish-vegetables culture non-saline Ghers needs to be selected. Duck shed has to be along the Gher dykes. The floor of the duck shed needs to be covered by gunny sacks to prevent the faeces to fall in the Gher water and to be easily collectible to use in the vegetable pits. High valued fishes (Koi, Shing and Magur) are cultured in the Gher. Farmers produce different vegetables all year round. In vegetables cultivation pheromone traps needs to be used for ensuring less mortality in fish.

Suitable location/ecosystem:

Mainly the non-saline Ghers in the coastal region can be cultivated in this system.

Benefits:

- Proper utilization of farm resources
- Increased cropping intensity produces high profit margin
- Improved practices such as pheromone traps reduces the insect infestation and helps in producing high quality vegetables and fish from Ghers
- High value fishes such as koi, shing and magur can be cultured in Ghers
- Ducks produce large amounts eggs

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Fact sheet-9

Title of the technology: Development of Mustard - Boro -T. Aman cropping pattern over Fallow- Boro -T. Aman cropping pattern

Introduction: Bangladesh is a small but the most densely populated (about 843 persons per sq. km) country of the world. Population is increasing annually at the rate of about 1.37 percent. Total cultivable land of the country is about 8.44 million hectares. Demographic pressures and increased urbanization have caused cultivated area to decline at a rate of 1 percent per year. Food requirement of the country is estimated to be doubled in the next 25 years. The demand has to be met from our limited and shrinking land resources. Bangladesh is predominantly a rice growing country and rice is the staple food. Rice occupies about 80% of the total cropped area and is cultivated in three seasons a year. On the other hand, we are very deficit in oil seed crop. The present cropping intensity of the country is more than 191%. In order to produce more food within a limited area, it is very important to increase cropping intensity and for this reason more suitable crop(s) should be included in the cropping pattern. Therefore, the pattern was undertaken to develop three crops-based cropping patterns against the existing Fallow-Boro-T. Aman rice cropping pattern

Description: In this cropping pattern three crops viz., Mustard and two rice crops are included. Dry land

preparation is required for the establishment of upland crop. The dry lands are prepared at the field capacity (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 *Kharif II* season with T. Aman rice followed by Mustard and Boro rice. The main field duration of the three crops is about 270-280 days. So careful attention was given to timely establishment of crops. To increase the turnaround time the crops were harvested at physiological maturity rather than at harvesting maturity. Fields should be released about seven days before the establishment of succeeding 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-based fertilizer dose was considered (BARC, 2018) rather than 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 Binasarisha-9. Mustard is usually sown in line with a spacing of 30 cm x continuous @ 7.5 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 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 third-last week of February and second to last week of July. Two times hand weeding is done following the urea top dressing. Boro rice variety Binadhan-10 and T. Aman rice variety Binadhan-17 is used in this technology. Seedling spacing is 20cm x 15 cm and numbers of seedlings are 2-3 seedlings 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 and high land under AEZ-13 and similar areas in Shyamnagar Upozilla of Satkhira district. 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 16.88 t ha⁻¹ (Mustard-Boro-T. Aman). The gross margin is 55.22% higher than the existing Fallow- Boro -T. Aman cropping pattern. The marginal benefit cost ratio of the improved cropping pattern is 1.92

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ii. Effectiveness in Policy Support

1. Household farming pattern diversified through integration of sub system (homestead. livestock and fisheries) with ensure better management of resources which make environmentally sustainable farming in costal ecosystem.
2. Through better utilization of fallow land of coastal areas, increasing cropping intensity and productivity through cultivation of intensive cropping pattern 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, 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.
3. Women empowerment will be ensured somehow through creating employment and income enhancement of women.

H. Technology/Knowledge generation/Policy Support

i. Immediate impact on generated technology

- Farmer’s income will be increased rapidly by using movable seedbed at least 4-5 folds, but the selection of the vegetable’s seedlings was most important.
- Modified Atkapalia and modified Lebukhali model followed for year-round vegetables and fruit production at homestead are more effective for costal ecosystem of Noakhali and Patuakhali region.
- Higher yield and cropping intensity increased by improved management practices and proper utilization of resources.
- Higher production leads to higher consumption rates added to nutritional support for coastal resource poor farmers
- Farmers around the sites adopted new technology
- Increases production and farmers’ income ultimately increase their livelihood and creates employment opportunities for day labors.

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

- The moveable seedbed technology should be demonstrated other coastal areas and further research should be conducted for producing seedlings throughout the year by using different kinds of organic substrates such as water hyacinth+ vermicompost, soil + straw + vermicompost, soil + sawdust +rice husk etc.
- Cropping pattern developed by inclusion of T. Aus rice, potato and sunflower in the existing cropping patterns should be further continued for more than two years with modern varieties developed by NARS Institute such as BARI, BIRRI and BINA.
- Modified Atkapalia Model and Modified Lebukhali Model should be continued in respect of more niches and more production system such as sack gardening, pot culture, vegetables production by using plastic bottle in waterlogged areas for better harvest of the sunlight and vertical gardening in the costal ecosystem.
- Ghore based integrated farming will be helpful for sustainable production system at costal ecosystem
- Ghers are highly productive areas where the utilization of resources is still not done properly, integration of different components of agriculture can help in the proper utilization
- In the coastal region, most of the areas affected by salinity in dry season. Generation of more saline tolerant varieties and management practices which may help in producing more crops during fallow period due to salinity.
- Location wise homestead vegetables and fruits production model may be modified for more suitability and acceptance.

- Cultivation of high value vegetables (Summer Tomato, Cauliflower, Cabbage and Brocoli) in nearby homestead area in stated of leafy vegetables
- Cultivation technique of Turmeric, ginge and Chui jhal 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.
- Inclusion of mustard in Boro-Fallow-T. Aman cropping pattern can increase system productivity
- Inclusion of T. Aus and sunflower in Grasspea -Fallow-T. Aman cropping pattern which can increase total farm productivity
- Inclusion of Khira + Turnip and T. Aus in Khira -Fallow-T. Aman cropping pattern which can increase total farm productivity in costal ecosystem of Satkhira
- Cultivation of newly BINA released rice varieties (Binadhan-10, Binadhan-11 and Binadhan-19) can increase system productivity
- Cultivation of newly BRRI released rice varieties (BRRIadhan 48, BRRIadhan 85, BRRIadhan 81, BRRIadhan 87 and BRRIadhan 88) which can increase farm productivity
- Cultivation of high yielding BARI Soyben-5 and 6 and BARI Mungbean-6, BARI Hybrid Maize-9, BARI Chinabadam-8, BARI Khesari-2, BARI Cheena-1, BARI Goam-25, BARI Surjomukhi and BARI Potato-72 varieties will be increased system productivity
- Vaccination and De-warming activities of cattle which can increase the weight and milk production as well prevent disease infestation
- Vaccination of poultry birds which can decrease mortality rate as well as increase in come of farmer.
- Cattle and goat rearing flowing modern technology can increase in come of house hold
- Sonali chicken, Turkey, duck (Khaki kamble) and Pigeon rearing under semi-scavenging system can increase in come of house hold
- Management of fruit trees increases production and income
- High value fishes species (khorkhullu, Faissa, coral, Shing, Magur and Koi) culture in mild saline Ghers at Satkhira.

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

- All the developed cropping pattern should be demonstrated in large scale with different costal ecosystem conditions prevailed in different years as well as socio-economic aspects.
- Year-round vegetables production in homestead area following 'Modified Atkapalia model for Noakhali region, modified Lebukhali mode for Patuakhali region and Laudov model for Satkhira region
- Year-round vegetables could be grown in the nearby homestead (Sumer tomato, Cabbage, Cauliflower, Brocoli, Brinjal, ladies figure, cucumber, watermelon sponggourd, Indian spinach etc.)
- Utilization of shady niches at the homestead areas by cultivation of spices (ginger, turmeric and Chui jhal).
- Gher-based integrated farming could be increased total productivity.
- Improvement of existing cropping patterns by introducing new high yielding and short duration crop varieties
- Vegetable base cropping patter non saline area of Satkhira region
- Three crops based cropping pattern at Noakhali and Patuakhali region.
- Introduction of new rice varieties replacing the older varieties
- Rearing of improved breeds of goat (Black Bangal), chicken (Sonali) and duck (Khaki Campbell) in farmers house hold
- Turkey and Pigeon rearing at homestead level.

- Carp polyculture in Gher of Satkhira region.
- High value fishes species (Khorkhullu, Faissa, coral, Shing, Magur and Koi) culture in mild saline Ghers of Satkhira.
- Carp poly culture and monosex tilapia culture in seasonal and perennial pond of non-saline area.
- Carp polyculture in seasonal mini pond
- Establishment of mini fruit orchard base Agroforestry system at homestead or nearby homestead.
- Fodder production in homestead or nearby homestead.

iv. Policy Support

- Technology generation and dissemination should be proceeded linearly for success of the Farming system Research and Development activities.
- Rural resource poor farmers are one of the main factors to consider in boosting countries total production in agriculture
- Introducing new technologies to the farmers helps them gradually adjust their traditional practices to more sustainable farming methods
- Integrated farming systems approach helps to increase the cropping intensity and crops diversity as well as production in the same lands where traditional practices have been going on
- Increased production gradually improves consumption and nutritional intake as well as the farmers' livelihood
- On account of the rural small scale agriculture's role in national GDP, more technological support needs to be provided throughout the country according to different AEZs

I. Information regarding Desk and Field Monitoring

i. Desk Monitoring

BARI Component: Not Applicable

BRRI Component

BARC have regularly arranged monitoring workshops to review the results and identify the different problems in each FSRD sites and to provide suggestions accordingly to the specific problems. Consultants and scientists of FSRD have regularly shared their experiences to help each other understand more about the FSRD approach.

BINA Component: Not Applicable

ii. Field Monitoring:

Table I.1 Field Monitoring information of BARI Component

Monitoring team	Date(s) of visit	Total visit till date (No.)	Remarks
Technical Division/ Unit, BARC	-	-	-
PIU-BARC, NATP-2	15.10.2019 30.06.2020	02	-

Table I.2 Field Monitoring information of BRRRI Component

Monitoring team	Dates of visit	Total no. of visits	Output
Technical division/unit, BARC	19.04.2019 14.09.2020	2	<ul style="list-style-type: none"> • Farmers share the problems they face regularly in the fields • Suggestions addressing the problems are given to the farmers • Farmers feel motivated
PIU-BARC, NATP-2	14.06.2019 14.09.2020	2	
Internal	The recruited Scientific Officer and a field assistant stays at the site office. The PI and Co-PI visit the site twice every month		

Table I.3 Field Monitoring information of BINA Component

Monitoring team	Date(s) of visit	Total visit till date (No.)	Remarks
Technical Division/ Unit, BARC	-	-	-
PIU-BARC, NATP-2	19.04.2019 14.06.2019	02	-
Internal Monitoring	-	-	-
Others Visitors (if any)	06.06.2019, 14.06.2019 06.03.2020	01 01 01	<ol style="list-style-type: none"> 1. Principal Investigator 2. Director General of BINA with PI



Picture I.1. Field visit by monitoring team



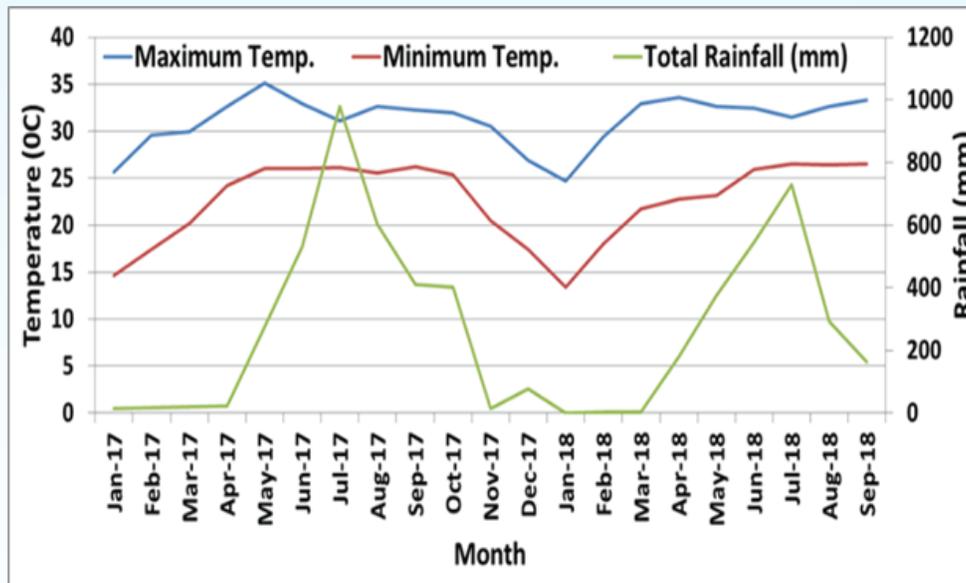
Picture I.2. Open discussion & workshop

iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities:

BARI Component

FSRD Site: Noakhali

Data on rainfall and temperature was collected from nearby station of Majidee court, Noakhali Sadar, Bangladesh Metrological Department (BMD), Noakhali (Graph 11.1.1.). Climatically, the region represents a very wet region with annual rainfall ranging from 2500 mm to 3000 mm. The highest temperature measured in April to May (33.750c) and the lowest in December to January (13.110c). After October, the temperature chronologically decreased up to January and again rises in February. The highest rate of rainfall was in May to September and the lowest in November to March compare than June-July. Little or no rainfall occurs in November to February. The area experiences a short duration of cool winter period. The natural hazards of the area are frequent cyclones and storm surges with exceptionally high tides.



Source: Meteorological Division, Noakhali

Figure I.1: Total rainfall, Maximum and Minimum temperature of Noakhali during the project intervention period (May, 2017 to September, 2018)

FSRD Site: Jamla, Patuakhali

The temperature ranges from 33 degree to 10 degree Celsius and the average annual rainfall ranges from 1840mm to 3148mm. Tidal water is a major problem in the FSRD site during the late *Rabi* and *Kharif-1* seasons. Sporadic soil salinity observed in some lands in January to April. Salinity level varies from 2 to 4 dS/m.

BRRI Component

The highest average temperature in Kaliganj, Satkhira during 2019-20 was in May (41°C) while the lowest temperature was in January 2020 (23°C). The highest average temperature in Kaliganj, Satkhira during 2020 was in April (39°C) (Appendix 5).

The yearly rainfall in Kaliganj, Satkhira during 2019 was 3842 mm and 2020 was 3947 mm. Peak rainfall was recorded during June-October (Appendix 6).

Salinity ranges were different in various locations. South and south-western zone of the area showed higher salinity over other areas. Salinity ranges depended mainly rainfall amount during the year. From different locations in the south-western zone salinity peak was recorded during February-April ranging from 6.5-10.5 dsm^{-1} . The salinity of the southern zone was recorded 30.4-34.48 dsm^{-1} during February-April.

Three cyclonic storms were experienced during 2018-20. Cyclone Fani during May 4, 2019, Cyclone Bulbul during November 11, 2019 and Super cyclone Amphan during May 20-21, 2020.

BINA Component:

Soil salinity in ranges from 2-12 ds/m and water salinity range from 2-18 ds/m.

J. Sub-project auditing

Table J.1. Sub-project auditing information of BARC component

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
GOB	No observation raised in 1 st and 2 nd and 3 rd financial year.	6337822	Satisfactory	Three audit has been completed

Table J.2. Sub-project auditing information of BARI component

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
GoB	No observation raised in 1 st , 2 nd and 3 rd financial year.	10955760	Satisfactory	Three audit has been done

Table J.3. Sub-project auditing information of BRRRI component

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
GOB	None	5979107	Satisfactory	Audit is completed

Table J.4. Sub-project auditing information of BINA component

Type of audit	Major observation/issues/object ions raised	Amount of audit	Status at the sub-project end	Remarks
GoB	No objection raised in first second and third financial year.	5291938	Satisfactory	Three audit has been completed

K. Lessons Learned:

- i) Diversification should be done within and beyond agriculture for preventing high migration of marginal group of farmers during dry season.
- ii) Environmentally friendly technology cost should keep low for the adoption of the technology.
- iii) Climate resilient farming for marginal farmers should not be like one technology fits for all marginals farmers' fields rather it should be more holistic approaches with capital item included.
- iv) Homestead production models can be utilized for better production
- v) Laudove model is suitable for year-round vegetables and fruit production in homestead of costal area of ShaTkhirra district
- vi) Short duration high yielding varieties and appropriate crop management practices could be improved the existing cropping pattern which ultimately increase total productivity.
- vii) Now mostly, two crops base cropping patterns has been practiced wall over the country which can be replaced by three or four crops base cropping patterns.
- viii) Livestock and fisheries technology should be more accessible to the farmers.
- ix) Semi-scavenging method of Sonali chicken, Khaki kemble duck and turkey rearing increases rural based resource poor farmers' income and nutrition availability
- x) Vaccination program of livestock and poultry birds is very essential and need to continue throughout the year
- xi) Coastal Ghers are highly productive areas where integration of different components can ensure high production and offers better income opportunity for the farmers
- xii) High value fish polyculture in Ghers can improve farmers' livelihood and make them adaptable to different problems faced in monoculture
- xiv) Generated information and technologies need to be further validated for refinement.
- xv) Activities need to be taken regarding agricultural mechanization and improvement of soil health.

L. Challenges

- i) Integration of all the components within the time frame of the project.
- ii) Fodder cultivation within the crop fields-a big challenge for sustaining livestock
- iii) High migration rate of marginal and small categories
- iv) Lack of mechanization, poor marketing facility and low price of crops
- v) Lack of knowledge among farmers about new crop varieties and technology
- vii) Lack of quality seeds /fingerlings
- vii) Salinity in soil and water, shortage of freshwater and irrigation facility
- viii) Irrigation facility development is also a prime need for the intensification of cropping in the region
- ix) Amphan cyclone and COVID-19 pandemic hamper project activity
- x) Sudden resignation of some project Scientific Officers and Field Assistants from the job created problem to proper implementation of the sub-project at field level
- xi) Lack of strong multi-disciplinary scientific team to implement the program
- xii) Project's scientists should be placed in each site especially for crop and fish components
- xiii) Training on different components of the farmers was insufficient.
- ivx) Shortage of skilled manpower especially in livestock, fisheries and Agril. Economic component.
- xv) Project period was limited it needs minimum five years for refined technological development.

M. Suggestions for Future Planning

- i) Adequate number of Scientific Officers and Scientific Assistants should be recruited for posting in each FSRD site

- ii) Monitoring /field visit/exchange visit should be more to evaluate the project activities
- iii) This type of project tenure should be at least five years for developed viable technology farming system research and developed.
- iv) Multidisciplinary well experienced strong scientific team needed for successful integration of technologies
- v) Scientific personnel (livestock, fisheries and agril. economics) should be placed site wise for smooth running of the project.
- vi) Strong linkage should be developed among the NARS. DAE, DLS and DoF for dissemination of technologies.
- vii) Farming system research and development (FSRD) activities may be strengthened throughout the country
- viii) Newly evolved technologies may be demonstrated in the Farming system research and development sites for rapid dissemination in future.
- ix) A permanent FSRD team comprises of crops, livestock and fisheries scientists should be placed permanently with supporting field staff.
- x) Generate a generalized model suited to various farm size holdings in different agro climatic conditions.
- xi) Irrigation facility development is also a prime need for the intensification of cropping in the coastal region
- xii) Agricultural knowledge of farmers needs to be developed through hands on training on different components are required to facilitate the improvement of the skill of the farmers.

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