



Annual Report 2019-20

NATP-2
BARC Component
Enhancing Agricultural Technology Generation



National Agricultural Technology Program-Phase II Project
Project Implimentation Unit
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

NATP-2

Annual Report 2019-20

PIU-BARC

Annual Report

(July 2019- June 2020)

Component-1

Enhancing Agricultural Technology Generation



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Foreword



The World Bank, International Fund for Agricultural Development, The United States Agency for International Development and the Government of Bangladesh funded National Agricultural Technology Program Project (NATP) is a comprehensive project with a focus on revitalizing the agricultural technology system and increasing agricultural productivity in Bangladesh. The long-term NATP development program is for a period of 15 years in three phases. The overall objective of the longer-term program is to improve national agricultural productivity, market and farm income, with a particular focus on small, marginal and female farmers. The development objective of the Phase II of the NATP is to strengthen the capacity of research of the national agricultural technology system in Bangladesh. The second phase officially begins in October 2015 and is scheduled to end in June 2023.

Out of the five components of NATP, the Project Implementation Unit (PIU) of BARC is the prime component for agricultural research and is the implementing arm of all NATP activities on behalf of the Bangladesh Agricultural Research Council. In attaining the project's objectives concerning BARC/NARS, the PIU-BARC in close collaboration with the NARIs and related others is undertaking activities to transform agricultural research more participatory and demand-driven and develop technologies to promote sustainable intensification, diversification, and mechanization of agriculture through efficient natural resources management.

The Annual Report for the year 2019-2020 consists of implementation progress of CRGs and PBRGs, monitoring and evaluation, environmental and social safeguard management, human resource development, procurement and financial management. Different chapters of this report describe the progress of technology generation, development and validation and related issues. This piece of the report would be useful for all the stakeholders and others.

I appreciate the efforts of the Director, PIU-BARC and his team and wish through collective efforts to reach the desired objectives of the NATP.

I appreciate the contribution and sincere efforts of all the researchers of NARS, universities. I acknowledge the hard work of the PIU-BARC personnel and the technical divisions of BARC to visualize the hard work through this report.

Dr. Shaikh Mohammad Bokhtiar
Executive Chairman

Preface



National Agricultural Technology Program-Phase 11 Project (NATP-2), a national project of the People's Republic of Bangladesh jointly funded by GoB and /IDA/IFAD/USAID has been started its interventions through the coordinated efforts of Ministry of Agriculture (Lead Ministry) and Ministry of Fisheries and Livestock to improve national agricultural productivity, market linkage and farm income, with a particular focus on small, marginal and female farmers. The agricultural research component- Enhancing Agricultural Technology Generation of NATP-2 is being implemented by the Project Implementation Unit (PIU) of BARC since 2016 in order to generate demand-driven technologies on crops, fisheries and livestock through executing basic, strategic, applied and adaptive research including research on cross cutting issues with NARS and non-NARS institutes for increasing the productivity and production of agricultural commodities.

A total number of 190 Competitive Research Grant (CRG) and 51 Program Based Research Grant (PBRG) sub-projects are being implemented by the 27 different NARS and non- NARS institutes. Although, implementation activities of the CRG sub-projects are completed and 69 demand-driven agricultural technologies have been developed. Out of 69, 11 technologies were handedover to DAE (6), DLS (3) and DoF (2) for dissemination in the farmers' fields. It may be expected that with the proper implementation of PBRG sub-projects, demand-driven agricultural technologies will also be generated which will help to achieve the food and nutritional security of Bangladesh.

Human resources are the vital force of national development. Thus agricultural manpower development is essential and more emphasis should be given to the NARS scientists. It is essential to develop scientists in such a way that they can face the future research challenges in all sub-sectors of agriculture. PIU-BARC, NATP-2 has selected and awarded 140 PhD programs (60 foreign & 80 local) to the scientists of NARS and Ministry of Agriculture against the targeted 140. Out of 20 local PhD programs allocated for DAE (10), DLS (5) and DoF (5). This annual report includes the activities performed by PIU-BARC, NATP-2 during FY 2019-20. I hope this publication will be useful to the scientists, extension workers, teachers, students and other stakeholders.

I gratefully acknowledge the direct and indirect contribution and support of all concerned extended in carrying out the activities of PIU-BARC component successfully during the FY 2019-2020 as well as publishing this annual report.

A handwritten signature in black ink, appearing to read 'Harunur Rashid'.

Dr. Md. Harunur Rashid
Director

Table of contents

Chapter Content/Section	Page no.
Foreword	ii
Preface	iii
Abbreviations & acronyms	vii
Executive summary	ix
Chapter-1	
Component-1 Research in brief	01
1.1 Specific objectives	01
1.2 Project components	01
1.3 Activities of PIU-BARC	01
1.4 Updated progress	02
1.4.1 Technical progress	02
1.4.2 Financial progress	02
Chapter-2	
Progress of CRG sub-projects	03
Chapter-3	
Progress of PBRG sub-projects	06
3.1 Progress of PBRG sub-projects	06
3.2 Institute wise distribution of PBRG sub- projects	06
3.3 Division/ Unit wise distribution of PBRG sub-projects	07
3.4 Sub-sector wise distribution of PBRG sub-projects	07
3.5 Updated progress	08
Chapter-4	
Coping mechanisms undertaken during COVID-19 Period	128
4.1 Monitoring during COVID-19 locked down	128
4.2 Impact of COVI-19 locked down on field implementation of PBRG sub-projects	128
4.3 Benefits of farmers by ongoing PBRG sub-projects during COVID-19	142
4.4 Impact of COVID-19 on PhD programs	142
4.5 Virtual meeting during COVID-19	143
Chapter-5	
Human resource development	144
5.1 Status of higher studies (Local and foreign PhD)	144
5.2 Contribution of PhD programs to achieve NATP objectives	144
5.3 Institute wise distribution of local and foreign PhD programs	145

5.4	University with no/minimal course work in foreign PhD programs	145
5.5	Progress of course and research work of overseas and in-country PhD programs	146
5.5.1	Overseas PhD programs	146
5.5.2	In-country PhD programs	147
5.6	Status of local and foreign training and workshop	147
5.7	International training	151
5.8	International workshop/seminar	151
5.9	International study visit	152

Chapter-6

	Environmental and social safeguard management	153
6.1	Environmental and social safeguard management activities performed under CRG and PBRG sub-projects	153
6.1.1	Overall activities performed under CRG and PBRG sub-projects	153
6.1.2	Information on CHT related researches under CRG and PBRG sub-projects	153
6.1.3	Food and nutritional security addressed through CRG and PBRG sub-projects	156
6.1.4	EX-ACT data questionnaire and climate co-benefits	157
6.1.5	The type and extent of climate-smart agriculture activities	157
6.2	Field monitoring on environmental and social safeguard management	157
6.3	Gender strategy	159
6.4	Indigenous people (IP) strategy	160
6.5	GRM management	160
6.6	Implementation, coordination and institutionalization	160
6.7	Environmental and social safeguard compliances	161

Chapter-7

	Monitoring and evaluation	162
7.1	Desk monitoring	162
7.2	Field monitoring	163
7.3	Field monitoring workshop	163
7.4	Monitoring team	164
7.5	Log frame based performance	169

Chapter-8

	Procurement management	170
8	Procurement progress	170

Chapter-9

	Financial management	172
9.1	Financial progress	172
9.2	Project financial management	172
9.3	Financial progress of PIU-BARC	172

Chapter-10

World Bank (WB) review mission	174
10.1 WB review mission	174
10.2 Matrix of mission visit	174
10.3 Review of task and assignment of WB mission	174

Chapter-11

Challenges faced and lessons learned	177
11.1 Challenges faced	177
11.2 Lessons learned	177

Project team	178
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Abbreviations and acronyms

AERS	:	Agricultural Economics and Rural Sociology
AI	:	Artificial Insemination
AIF-1	:	Agricultural Innovation Fund
ARS	:	Agricultural Research Station
BARC	:	Bangladesh Agricultural Research Council
BARD	:	Bangladesh Academy for Rural Development
BARI	:	Bangladesh Agricultural Research Institute
BAU	:	Bangladesh Agricultural University
BFRF	:	Bangladesh Fisheries Research Forum
BFRI	:	Bangladesh Fisheries Research Institute
BFRI	:	Bangladesh Forest Research Institute
BIM	:	Bangladesh Institute of Management
BINA	:	Bangladesh Institute of Nuclear Agriculture
BJRI	:	Bangladesh Jute Research Institute
BLRI	:	Bangladesh Livestock Research Institute
BRRI	:	Bangladesh Rice Research Institute
BSRI	:	Bangladesh Sugarcrop Research Institute
BSRTI	:	Bangladesh Sericulture Research and Training Institute
BTRI	:	Bangladesh Tea Research Institute
BSMRAU	:	Banghabondhu Sheikh Mujibur Rahman Agricultural University
CA	:	Conservation Agriculture
CDB	:	Cotton Development Board
CN	:	Concept Note
Co-PI	:	Co-Principal Investigator
CRG	:	Competitive Research Grant
CSO	:	Chief Scientific Officer
CT	:	Conventional Tillage
CU	:	Chittagong University
CVASU	:	Chittagong Veterinary and Animal Science University
DAE	:	Department of Agricultural Extension
DLS	:	Department of Livestock Services
DoF	:	Department of Fisheries
DPP	:	Development Project Proposal
DU	:	Dhaka University
EC	:	Executive Council
EMF	:	Environmental Management Framework
ERD	:	Economic Relation Division
FRP	:	Full Research Proposal
FY	:	Financial Year
GDP	:	Gross Domestic Product
GIF	:	Gender and Inclusion Framework
GoB	:	Government of Bangladesh
GTI	:	Graduate Training Institute
HOPE	:	Head of Procuring Entity
HRC	:	Horticulture Research Centre
HRD	:	Human Resource Development
HSTU	:	Hajee Mohammad Danesh Science and Technology University

IDA	:	International Development Association
IFAD	:	International Fund for Agricultural Development
IPM	:	Integrated Pest Management
KU	:	Khulna University
ISM	:	Implementation Support Mission
LoA	:	Letter of Agreement
M&E	:	Monitoring and Evaluation
MD	:	Member Director
MoA	:	Ministry of Agriculture
NARS	:	National Agricultural Research System
NATP	:	National Agricultural Technology Project
NARI	:	National Agricultural Research Institute
NATA	:	National Agricultural Training Academy
NRM	:	Natural Resource Management
NGO	:	Non-Governmental Organization
NIB	:	National Institute of Bio-technology
NSTU	:	Noakhali Science and Technology University
OFRD	:	On Farm Research Division
P&E	:	Planning and Evaluation
PAD	:	Project Appraisal Document
PBRG	:	Program Based Research Grant
PCR	:	Project Completion Report
PDO	:	Project Development Objective
PhD	:	Doctor of Philosophy
PHTD	:	Post Harvest Technology Division
PI	:	Principal Investigator
PIM	:	Project Implementation Manual
PIU	:	Project Implementation Unit
PMP	:	Project Management Plan
PMU	:	Project Management Unit
PSO	:	Principal Scientific Officer
PSTU	:	Patuakhali Science and Technology University
R & D	:	Research and Development
RADP	:	Revised Annual Development Program
RARS	:	Regional Agricultural Research Station
RPA	:	Reimbursable Project Aid
RU	:	Rajshahi University
SAU (Dhaka)	:	Sher-e-Bangla Agricultural University
SAU (Sylhet.)	:	Sylhet Agricultural University
SDA	:	Sustainable Development Associates
SMF	:	Social Management Framework
SoE	:	Statement of Expenditure
SRDI	:	Soil Resources Development Institute
SUST	:	Shahjalal University of Science and Technology
SSURDA	:	Society for Sustainable Development for Rural Urban Area
USAID	:	United States Agency for International Development
VAT	:	Value Added Tax
WB	:	World Bank

Executive summary

The National Agricultural Technology Program Phase-II Project (NATP-2) has five inter related components of which Component 1: Enhancing Agricultural Technology Generation is being implemented by PIU-BARC with NARS and non-NARS institutes (Public universities, NGOs and other organizations). The research component supports technology generation on crops, fisheries and livestock by executing Competitive Research Grant (CRG) and Program Based Research Grant (PBRG) sub-projects. PIU-BARC is also shouldering programs for human resource development (80 local PhDs, 60 foreign PhDs, short-term training, study visit, etc.) of NARIs. This report highlighted the detailed progress of activities made by the Component-1 (PIU-BARC) until June 2020.

The planned activities of PIU-BARC designed in the DPP are to implement a) 100 CRG, b) 33 PBRG, c) 80 local & 60 foreign PhDs, d) short-term training, workshop/seminar, study visit, etc. and e) improvement of research and training facilities in NARIs, particularly in outreach stations (RARS/ARS).

At this stage of project implementation, the component successfully completed field execution of 190 CRG sub-projects and generated 69 potential technologies. Sixty-nine technologies identified from CRG Sub-Projects of which 20 technologies were presented by the PIU-BARC in a workshop organized by PMU in mid-February 2020 in presence of Directors/ representatives of all PIUs (DAE, DoF and DLS) to identify the demonstrable ones for the extension agencies. The workshop identified 11 (6 for crops, 3 for livestock and 2 for fisheries) technologies for immediate field demonstration and decided to present these technologies in an extension-research liaison workshop held at Jashore on 25 February 2020. During presentation of technologies in the liaison workshop, the participants (field officials of DAE, DoF and DLS) showed keen interest for demonstration trials of the technologies. Accordingly, the PIU-BARC provided the technology fact sheets of those identified technologies to the concerned PIU-Directors of DAE, DoF and DLS in 1st week of March 2020 with a copy to the respective PIs of the research sub-projects for their onward cooperation towards technology transfer activities. For further follow up of the technology transfer issues, the Director PIU-BARC issued request letter to the PD, NATP-2 in 1st week of June 2020 to arrange a coordination meeting among all stakeholders to expedite it.

The field implementation of 51 PBRG sub-projects is moving forward successfully in the field through 190 components with nationwide coverage. All PIs are regularly submitting half-yearly and annual reports of their sub-projects and satisfactory progress is being made in field/lab works including data generation through field survey. Until June 2020, BDT 7017.07 lakh (54.60%) disbursed to the PBRGs against the DPP target of BDT 12842.00 lakh. None of the sub-projects completed field works yet. All 51 sub-projects are scheduled to be completed field works by June 2021.

Under human resource development, 140 PhD programs (80 local and 60 foreign) are moving forward with good progress. Local scholars of PhD presented their research/course works at two workshops organized by PIU-BARC. Due to COVID-19 pandemic, the scholars became compelled to be in a break period of more than 3 months when they were unable to continue works at field and lab. Most of scholars informed may need time extension of 6-12 months and additional funding to complete the programs. Good progress has been made in implementing local training/workshop (73%). Where, the progress in case of the foreign training/workshop is less (24%) as hiring of international firm was not possible.

Due to COVID-19 incidence many scheduled activities have been temporarily dropped as GoB declared general holidays from 26 Mar to 30 May 2020. During the lockdown period the PIU-BARC continued activities through virtual meetings and on-line surveys of field implementation status of the planned activities. During last week of March 2020 to 1st week of June 2020, the Director, PIU BARC organized and attended a number of virtual meetings with the PMU in April and May 2020, Executive Chairman BARC, Coordinators/Pis of the PBRG sub-projects. Accordingly a short email survey was initiated during 3rd week of April and May for assessing impact of COVID-19 on the activities of PBRG sub-projects, PhD programs and training/workshop

activities. Around 120 PIs of 44 PBRG sub-projects responded in the on-line survey. The major findings of the short surveys are presented in this report.

The environmental and social safeguard management including major environmental and social safeguards, gender and indigenous people's (IP) strategies and grievance redress mechanism (GRM) issues have been addressed adequately during project period through selection and monitoring of CRG and PBRG sub-projects and workshop, training, seminar, field days etc. The environmental and social safeguards are being applied to all the research sub-projects in different stages of the project cycle. All the awarded CRG and PBRG sub-projects addressed environmental and social safeguard issues directly or indirectly to improve environmental and social development through sub-project interventions. PIU-BARC, NATP-2 awarded 14 CRG sub-projects implemented by different organizations in CHT districts and 6 PBRG sub-projects/components those have been implementing in CHT region to develop location specific technologies to address different aspects of agricultural production to improve the livelihoods of the farmers of the different tribal communities/Jhumia community (Shifting cultivators)/Indigenous People (IP) living in these areas. Identified 33 CRG sub projects and 28 PBRG sub-projects implemented to ensure the overall food and nutritional security/safety issues, 27 CRG sub-projects and 6 PBRG sub-projects are related to climate/co-benefits and 17 CRG sub-projects and 6 PBRG sub-projects are related to climate-smart agriculture. Out of 140 local and foreign scholars have 27 research topics are related to climate change adaptation, resilience/ or mitigation in agriculture. All the project activities of PIU-BARC implemented in the reporting year are met with total compliances to environmental and social safeguards.

Both desk and field monitoring techniques are being adopted for monitoring of the activities of PBRG sub-projects. Under desk monitoring evaluated the half-yearly and annual reports submitted by the PIs of PBRG sub-projects, organized monitoring workshop, and annual progress review workshops. The activities of PhD programs are being monitored mainly through organizing workshops where the scholars present their progress of course and research works. For field monitoring of PBRG sub-projects, the coordinators of PBRG sub-projects in BARC and PIU-BARC jointly reviewed the field activities and presents the findings in monitoring workshop in presence of all PIs and coordinators. Expert members of different technical subjects are present in the monitoring workshop who critically evaluates the strengths and weakness of the field implementation status of sub-projects. For the reported year, out of 9 scheduled field monitoring visits, 05 (56%) completed and reported. After field monitoring in northern region the monitoring team reported that when crop establishment done by mechanical seeder, in many cases uneven plant population (germination) of wheat (ID # 005) was observed and suggested to use more trained operators. Monitoring and progress review workshops could not be organized due to the effect of COVID-19.

During the reporting year, out of total 19 procurement packages 8 (42%) were completed as such 3 (50%) for Goods, 2 (25%) for Works and 3 (60%) for Services. Whereas the cumulative procurement Progress has been made 64% where goods Package made 64% progress, works package 40% and service package 77%.

The ADP expenditure of the fiscal year, 2019-20 rose to 78% for GoB, 84% for RPA and gross achievement is 84%. The cumulative achievement observed 35% progress in GoB fund and 41% for RPA and overall financial progress 40% and physical progress 58%.

Chapter-1

Component – 1 Research in brief

The PIU-BARC is one of the components of NATP-2 project deals with enhancing agricultural technology generation through implementing CRG (Competitive Research Grant) and PBRG (Program Based Research Grant) sub-projects. The component has the provision for human resource development of NARS institutions through awarding local & foreign PhD programs, and local & foreign training programs, workshops, seminars, study visits etc. Capacity development of research systems of all NARS institutions by providing modern lab equipment and establishing ICT facilities is another planned activity of the component. The Bangladesh Agricultural research council (BARC) as an apex body of the NARS is implementing the research component (Component 1) of NATP program phase II project. The component has started functioning in Sep 2016 and completed field implementation of large numbers of CRG research sub-projects. The Director, who is deputed from BARC acted as an administrative head of the component. Numbers of PBRG research sub-projects have also been awarded to the scientists of NARS institutions, universities and other relevant organizations; those are currently in operations at the field.

This report described the detailed activities of 2019-2020 of the research component, NATP program phase-II project, and highlighted the cumulative progresses of major intervention of the component.

1.1 Specific objectives

- One hundred (100) Competitive Research Grant(CRG) proposals to be undertaken;
- Thirty three (33) Program Based Research Grant(PBRG) proposals to be undertaken;
- Forty (40) improved technologies to be demonstrated in the farmers' fields of project areas;
- Targeted HRD Programs (80 local PhDs, 60 foreign PhDs, short-term training, study visit, etc.) to be implemented and
- Research and training facilities in NARIs, particularly in outreach stations (RARS/ARS) will be improved.

1.2 Project components

PIU-BARC is one of the five inter-related components of National Agricultural Technology Program-Phase II Project (NATP-2). The components are specifically responsible for addressing a wide range of constraints to technology generation, to technology transfer and adoption at farm level, and to farmers' access to markets. The components are:

- Component – 1: Enhancing Agricultural Technology Generation is being implemented by the Project Implementation Unit (PIU) of Bangladesh Agricultural Research Council (BARC);
- Component – 2: Supporting Crop Development is being implemented by the PIU of Department of Agricultural Extension (DAE);
- Component – 3: Supporting Fisheries Development is being implemented by the PIU of Department of Fisheries (DoF);
- Component – 4: Supporting Livestock Services is being implemented by the PIU of Department of Livestock Services (DLS) and
- Component – 5: Project Management is being implemented by the Project Management Unit (PMU), NATP-2, MoA.

1.3 Activities of PIU-BARC

The major activities of the PIU-BARC (Component – 1) of the NATP phase-II project includes:

- A. Awarding 100 (one hundred) CRG sub-projects;
- B. Awarding 33 (thirty three) PBRG sub-projects;
- C. Arrangement for effective supervision, monitoring and evaluation of the on-going CRG and PBRG sub-projects by the respective recipient research organizations and BARC as well as

- PIU-BARC;
- D. Improving research and training facilities in outreach stations (RARS/ARS) of NARIs;
 - E. Implementing HRD Programs – 80 local PhDs, 60 foreign PhDs, Short-term training, Study visit, etc.;
 - F. Organizing need based workshop, seminar, consultation meeting, etc.
 - G. Strengthening ICT facilities at the NARS institutes to establish information network connectivity between Head Quarter and Regional Stations of NARIs.

1.4 Updated progress

1.4.1 Technical progress

The following Table 1.1 showed the updated (till Jun 2020) cumulative progress of the component by major items. The technical progress for research sub-projects exceeded 100% while the progress of both local and foreign PhDs is reached at 100%. Considering the DPP target regarding the participants attended in local training and workshops has achieved good progress while the progress of International training and workshop is 20% and 30%, respectively. Organizing International training/workshops retarded due to not recruit of planned consulting firm. The procurement of firm is under process.

Table 1.1: Technical progress against major items of PIU-BARC, NATP-2 on 30 June 2020

SI #	Item	Project target	Progress	Progress (%)
1	CRG Sub-project (#)	100	190	190
2	PBRG Sub-project (#)	33	51	155
3	Local PhD (#)	80	80	100
4	Foreign PhD (#)	60	60	100
5	National Training (batch)	99	91	92
6	National Workshop (batch)	100	56	56
7	International Training (person)	260	52	20
8	International Study visit/Workshop/Seminar (person)	200	59	30

1.4.2 Financial progress

The following Table 1.2 showed the updated (till June 2020) cumulative financial progress of the component by major items. The financial progress for research sub-projects reached 73% for CRGs and 54% for PBRGs while the progress of both local and foreign PhDs is attained 42% and 47%, respectively. Considering the DPP target the component burned 71% fund allocation against national training/workshop and 28% for International training/workshop/study visit. Organizing International training/workshops retarded due to not recruit of planned consulting firm. The procurement of firm is under process.

Table 1.2: Financial progress (Tk. in lac) against major items of PIU-BARC, NATP-2 till June 2020

SI #	Item	Project target (Tk in lac)	Progress (Tk. in lac)	Progress (%)
1	CRG Sub-project	5951.00	4363.52	73.00
2	PBRG Sub-project	12842.00	7017.07	54.60
3	Local PhD	1100.00	515.80	46.90
4	Foreign PhD	4710.00	2324.57	49.30
5	National Training/workshop	695.00	496.44	71.00
6	International training/Workshop/visit	2160.00	613.68	28.00

Chapter-2

Progress of CRG sub-projects

Among the five inter related components of NATP-2, Component-1 (Enhancing Agricultural Technology Generation) is being implemented by PIU, BARC with the National Agricultural Research System (NARS) and non-NARS (Public Universities, NGOs and Other organizations) institutes. The research component has been supporting the generation and development of agricultural technologies on crops, fisheries and livestock through implementing Competitive Research Grant (CRG) and Program Based Research Grant (PBRG) sub-projects for increasing the productivity and production of agricultural commodities. PIU-BARC, NATP-2 has already developed an Operational Guideline for Agricultural Innovation Fund (AIF-1) for its efficient management. AIF-1 fund is being used to cover the sub-project research and related cost.

The first window of NATP-2 research investment is Competitive Research Grant (CRG) program that promotes demand driven basic, strategic, applied and adaptive research with better research extension-farmer linkages. CRGs were open to all research providers-National Agricultural Research System (NARS) and non-NARS research providers (Public Universities, NGOs and Private Organizations). In the CRG system, research providers were selected on competitive basis using call for research proposals and subjected them to rigorous review by the peer reviewers before being selected for funding. CRG programs were fully funded through the USAID Trust Fund (TF) which has already been closed on September 30, 2018.

The PIU-BARC had awarded 190 CRG sub-projects against the target of 100 allotted in DPP during March to June 2017. Implementation of 190 CRG sub-projects has been completed by the Principal Investigators (PIs) of the 27 NARS and non-NARS institutes. A total of 190 Project Completion Reports (PCRs) of the implemented 190 CRG sub-projects have been received from the Principal Investigators (PIs) as per prescribed format of PIU-BARC, NATP-2. All the received PCRs have already been reviewed by independent reviewers and corrected by the Consultants of PIU-BARC, NATP-2 with the cooperation of Principal Investigators of each CRG sub-project. After evaluation 69 transferable technologies have been identified from the findings of the completed CRG sub-projects for dissemination to the end users through DAE, DLS and DoF which are mentioned below.

Crops:

1. Bio-organic fertilizer: A green technology to improve soil health and rice yield (ID 707)
2. Crop productivity enhancement in beel areas (ID 688)
3. Tobacco replacement in char land through high value crops (ID 440)
4. Integrated rodent management of rice and wheat (ID 729)
5. Production and bulb preservation technology of Liliium (ID 479)
6. Improved sugarcane power crusher for gur production (ID 748)
7. Non-chlorine sanitizers for safe and quality betel leaf production (ID 452)
8. Optimization of Pre-Harvest Interval (PHI) of commonly used pesticides in tomato and country bean (ID 529)
9. Improved cropping patterns for productivity enhancement in Sylhet region (ID 490)
10. Integrated Pest Management (IPM) for sustainable tea production (ID 337)
11. Improved cropping patterns for productivity enhancement in enclaves (Sitmahal) of northern Bangladesh (ID 672)
12. Introduction of high value vegetables in Sylhet region (ID 345)
13. Integrated management of major insect pests of soybean (ID 732)
14. Bio- rational management of fruit-flies of fruits and vegetables (ID 526)

15. Eco-friendly management of sucking insects in cotton (ID 584)
16. Eco-friendly Integrated management for major insect pest and diseases of chilli (ID 477) 17. Bagging technology for safe and quality mango production (ID 444)
18. Management of bacterial diseases of silkworm (*Bombyx mori* L.) (ID 518)
19. BARI Surjamukhi-2: A promising salt tolerant sunflower variety (ID 459)
20. BARI Sarisha-16: A promising salt tolerant mustard variety (ID 459)
21. Healthy seedling raising of boro rice against blight disease (ID 708)
22. Ankuri: A healthy rice seed germinator and disinfectant
23. BRRI head-feed mini combine harvester (ID 705)
24. BRRI dhan9I: A high yielding deepwater rice variety (ID 765)
25. Management of insects and diseases of rice under changing climate in southern region (ID 698)
26. Quality seed production of BRRI released rice varieties at farmers' level (ID 716)
27. Ginger production under soilless culture using fertigation technique (ID 323)
28. Maize based cropping patterns for sustaining soil fertility and enhancing income (ID 382) 29. Management of acid soils for sustainable crop production (ID 419)
30. Fertilization for rooftop gardening (ID 499)
31. Crop yield enhancement in saline soil using polythene mulch and potassium fertilization (ID 570)
32. Exploitation of kitchen waste for vermicompost production and utilization (ID 735)
33. Vermicompost and organic manure: Improvement of soil fertility and crop productivity (ID 802)
34. BTRI tea clones for enhancing quality seed production (ID 342)
35. Tomatillo: A unique introduction as new crop (ID 376)
36. Cotton production in the drought prone Barind Tract (ID 583)
37. Eco-friendly technology for promoting vegetable production on rooftop (ID 623)
38. Enhancing crop productivity in saline area through climate smart technologies (ID 656) 39. Productivity enhancement of kenaf in char lands (ID 755)
40. Productivity enhancement of saline areas through underutilized crops (ID 768)
41. Improved cropping pattern for productivity enhancement in coastal areas (ID 442)
42. Safe vegetable production in urban area through vertical farming (ID 521)
43. Mechanical coconut de-husking machine (ID 307)
44. Improved coconut tree climber (ID 307)
45. Power operated oil palm fruit stripper (ID 576)
46. Productivity enhancement of lac through modern production practices (ID 528)
47. Shelf stable value added products of onion, garlic and ginger (ID 728)
48. Fresh cut processing technologies for fruits and vegetables (ID 465)
49. Gummosis management of shade trees in tea garden (ID 815) ee-ozd-c-i 9
50. Moringa based agro-forestry system for increasing productivity (ID 432)
51. Agor-based agro-forestry system for Sylhet region (ID 439)

Fisheries:

52. Productivity enhancement of coastal gher through year round Shrimp-Tilapia alternate culture (ID 778)
53. Culture of short cycle high valued fish species in the drought prone semi-arid zone of Bangladesh (ID 825)
54. Mixed culture of Galda and native Cat fish in south-western coastal gher (ID 827)
55. *Hygroryza aristata*: A floating grass utilized as fish feed is a new initiative for sustainable aquaculture (ID 410)
56. Captive culture of Seabass in the coastal brackish and freshwater of Bangladesh (ID 464)
57. Breeding and larval rearing technique of Gutum (*Lepidocephalichthysguntea*) (ID#553)
58. Production enhancement of craps and tilapia in creeks of Chittagong Hill Districts (ID # 833)

59. Culture of nutrient rich live feed (micro algae) for larvae of brackish water fish (ID 779)

Livestock:

60. Floating bed fodder cultivation in submerged and flooded areas (ID 647)
61. Cost effective complete pellet feed for commercial goat and sheep production (ID 788)
62. Low-cost technology for making processed cheese (ID 661)
63. Suitable estrus synchronization protocols for treating an-estrus cows (I D313)
64. Duck diseases in Hakaluki and TanguarHaor and their preventive strategies
65. Pro-biotic food products for human and feed products for poultry (ID 532)
66. Suitable long bone fracture management techniques in animals (ID 533)
67. Formalin killed egg drop syndrome vaccine using local isolates(ID# 556)
68. Manipulative reproduction technologies for quick genetic improvement in cattle (ID 603)
69. Pro-biotic feed supplement for calves (ID 790)

Factsheets of the identified 69 technologies have been prepared and uploaded in the web site of PIU-BARC .Out of 69 identified technologies, the following 11 technologies (Crops-6, Livestock-3 and Fisheries-2) have been selected by DAE, DLS and DoF in a workshop /discussion meeting organized by PMU, NATP-2 in mid February 2020 for demonstration in the farmers fields of the project area:

Crops:

1. Tobacco replacement in char land through high value crops (ID 440)
2. Crop productivity enhancement in beel areas (ID 688)
3. Bio-organic fertilizer: A green technology to improve soil health and rice yield (ID 707)
4. Bagging technology for safe and quality mango production (ID 444)
5. Optimization of Pre Harvest Interval (PHI) of commonly used pesticides in vegetables (ID 529)
6. Introduction of high value vegetables in Sylhet region (ID 345)

Livestock:

1. Cost effective complete pellet feed for commercial goat and sheep production (ID 788)
2. Pro-biotic feed supplement for calves (ID 790)
3. Low-cost technology for making processed cheese (ID 661)

Fisheries:

1. Culture of short cycle high valued fish species in the drought prone areas of Bangladesh (ID 825)
2. Mixed culture of Galda and native Cat fish in south-western coastal ghers(ID 827)

Selected 11 technologies has also been presented in an extension liaison workshop on 25 February 2020 in presence of field officials of DAE, DLS and DoF, and the participants showed their keen interest for conducting demonstration trials of the technologies. Factsheet of the selected 11 technologies has already been handed over to DAE, DLS and DoF with a copy to the respective Principal Investigators of the CRG sub-projects for their onward cooperation towards technology transfer activities. Different types of publications (Booklet, Leaflet, Factsheet, Poster and Scientific article) have also been published from the achievements of the implemented Competitive Research Grant (CRG) sub-projects. It may be mentioned here that all physical and financial activities of CRG sub-projects has already been completed in September 2018.

Chapter-3

Progress of PBRG sub-projects

3.1 Progress of PBRG sub-projects

The second window of NATP-2 research investment is institutional Program Based Research Grant (PBRG) including research on cross cutting issues. National Agricultural Research Institutes (NARIs) has made considerable success in technology generation but could do much more if enough financial supports provided to strategic inter-disciplinary research on particular facets of demand led areas. To this effect, the designed institutional PBRG of NARIs would be conducive and effective approach. PBRG would make stronger footing with team building holistic research culture for achieving desired output for commodities and production practices. Most importantly, coordinated PBRG program amongst NARIs has widen scopes in integrating multiple organizations for jointly combating national agricultural problems and strengthening their research and research management capability apart from effective and proper resource uses in national perspectives.

PBRG programs are being coordinated involving at least two research providers: coordination can be inter-institutional or it can be interdisciplinary within the institute. According to operational guideline of AIF-1, PIU-BARC advertised/invited Concept Note (CN) for PBRG sub-projects on 03 October 2016 (First Call). PIU-BARC received 150 CN of PBRG research proposals. Nine Technical committees of different Technical Divisions of BARC reviewed 150 CN of PBRG research proposals and selected 48 CN for submission of Full Research Proposals (FRP). According to Project Implementation Manual (PIM), two independent reviewers reviewed each Full Research Proposal (FRP). After rigorous review, Executive Council (EC) of BARC approved 42 but offered 40 PBRG sub-projects against the DPP target of 33 with BDT 103.54 crore as per LOA signed. Later on, another 11 new PBRG sub-projects has been approved by the Executive Council (EC), BARC and accordingly awarding and LoA signed of 11 new PBRG sub-projects have been completed with an amount of BDT 23.82 crore by maintaining all the formalities as per operational guideline of AIF-1. It may be mentioned here that rest amount of BDT 1.06 croe out of 128.40 crore allocated for PBRG has been reallocated to the PBRG sub-projects having ID # 087 and 138 as additional fund to meet up their requirements for achieving the set objectives of said sub-projects. LoA signed of 51 PBRG sub-projects including 11 new are being implemented by the 34 NARS Institutes, Public Universities and other organizations. The duration of the PBRG sub-project is maximum 4 (Four) years or less i.e. up to June 2021. The Principal Investigators have to complete the field/lab research activities within December 2020 and has to submit draft Project Completion Report (PCR) along with necessary data and information to the Coordination Component within March 2021. The Coordination Component is to submit the final PCR to the PIU-BARC, NATP-2 within June 2021. All activities of PBRG sub-projects are to be completed no later than one year prior to NATP-2 closing date in order to allow enough time to adequately disseminate the research results.

3.2. Institute wise distribution of PBRG sub-projects

PBRG sub-projects are coordinated and different NARS and non-NARS institutes have been implementing the researches on the same researchable issues. Though the numbers of PBRG sub-projects are 51 but the implementing components are 190. The Coordinators are mostly from different technical divisions of BARC who are coordinating and synchronizing the research activities among the Components. It has been observed from the table-3.1 that BARC alone coordinating 63% PBRG sub-projects. On the other hand BARI, BRRI, BFRI, BINA and BWMRI has been coordinating 17%, 12%, 04%, 02% and 02% of PBRG sub-projects, respectively

Table 3.1: Institute wise distribution of PBRG sub-projects

SL #	Name of Institute/ organization	No. of Coordinator	No. PBRG sub-projects	Percent of PBRG sub-projects
1	BARC	09	32	63
2	BARI	06	09	17
3	BRRI	04	06	12
4	BFRI (Fisheries)	02	02	04
5	BINA	01	01	02
6	BWMRI	01	01	02
Total		23	51	100

3.3 Division/ unit wise distribution of PBRG sub-projects

Table-3.2 showed the distribution of PBRG sub-projects under different technical division/unit of BARC. It has been found from the table-2 that the maximum numbers of PBRG sub-projects are being executed under Crops Division (31%) followed by fisheries (19%), Livestock (08%), Planning & Evaluation (08%), Forest(08%), Nutrition (08%), AERS (06%), Soil (06%) and Agricultural Engineering (06%).

Table 3.2: Division/ unit wise distribution of PBRG sub –projects

SL #	Division/ discipline/unit	Number of PBRG sub-projects	Percent of PBRG sub-projects
1	Crops	16	31
2	P &E	04	08
3	AERS	03	06
4	Soil	03	06
5	Forest	04	08
6	Agril. Engg.	03	06
7	Nutrition	04	08
8	Fisheries	10	19
9	Livestock	04	08
Total		51	100

3.4 Sub-sector wise distribution of PBRG sub-projects

It has been observed in table-3.3 that the maximum numbers of PBRG sub-projects are being executed under crops sub-sector (73%) followed by fisheries (19%) and livestock (08%).

Table 3.3: Sub-sector wise distribution of PBRG sub-projects

SL #	Name of sub-sector	Number of PBRG sub-projects	Percent of PBRG sub-Projects
1	Crops	37	73
2	Fisheries	10	19
3	Livestock	04	08
Total		51	100

3.5 Updated progress

After completing the awarding and signing of LoA, the PIU-BARC started releasing fund for the PBRG sub-projects from February 2018. By June 2020, all of the Coordinators and Principal Investigators of the first call 40 PBRG sub-projects submitted their half-yearly and annual reports. On the other hand, Coordinators and Principal Investigators of 11 new PBRG sub-projects which are being implemented since October 2019 has already been submitted the inception reports and some of them have submitted the 1st half yearly reports. Reviewing the half-yearly and annual reports it has been observed that most of the PBRG sub-projects are moving forward successfully for achieving the set objectives in the approved proposal. Implementation progress of the PBRG sub-projects are being monitored by the field monitoring teams formed by the PIU-BARC. However, on-line survey report as well as virtual meeting with the Coordinator and Principal Investigators indicated that limited impact has occurred on the field activities of the PBRG sub-projects due to COVID-19 pandemic and they are hopeful to complete their sub-projects by time schedule but simultaneously they have mentioned if the locked down continued for months then time extension would be needed to achieve the set objectives and also for completion of the sub-projects. Although, most of the PBRG sub-projects (1st call) completed more than two implementation year yet, none of the sub-projects have reached in a stage of technology generation, some more crop seasons would be needed to draw any conclusive inferences as per set objectives. As observed with few exceptions maximum sub-projects have able to make noticeable progress in the field as well as in the lab. The updated progress and results achieved by PBRG sub-projects are as follows:

1. Sub-project title: Up-scaling and application of solar photovoltaic pump for smallholder irrigation and household appliances in the central coastal region of Bangladesh (ID 001)

Coordinator : Member Director (NRM) BARC, Farmgate, Dhaka.

Implementing organization : BARI & BRRI

General objective:

- i. Up-scaling of solar pump for smallholder irrigation in the central coastal region of Bangladesh
- ii. Field trials and demonstrations of solar pump irrigation systems with surface water for high value crops and rice
- iii. Application of solar photovoltaic panel (both portable and non-portable) to operate household appliances round the year during off irrigation period
- iv. Analyzing the technical and economic feasibility of solar pump for multiple uses

Duration : February 2018 to June 2021

Budget : Tk 2,83,82,520/-

Background: There is about 62% irrigation coverage of which 82% operate on diesel engine and 18% on electric motor operated pumps. The diesel-run irrigation pumps consume more than half a million tons of diesel per annum. Solar photovoltaic power production is recognized as an important issue for generation of future energy requirement. There are about 320 solar power operated irrigation pumps in Bangladesh. In order to promote more solar pumps, the government has targeted to install about 15,000 solar pumps by 2025. Most of the farmers in the southern coastal region are small and marginal tenant farmers who have limited access to ground water utilization for crop cultivation and grow only rainfed aman rice during monsoon, so, lands remain fallow in dry season. Farmers are not interested to cultivate boro rice due to lack of suitable low lift surface pumps and high irrigation cost. Solar pump, which is pollution free and environment friendly, could be an alternative to diesel and electricity operated pumps for irrigating in the off-grid areas. Using solar pumps on a large scale, energy demand in irrigation systems can be reduced substantially. The sub-project is aligned with the government policy of Bangladesh as well as SDGs of the United Nations. The sub-project is being implemented by BARI and BRRI under the coordination of Natural Resources Management Division of BARC.

Progress: The sub-project has three components- BARC, BARI and BRRI. BARC component coordinates the activities of other two components. BARI and BRRI components work in 12 sites in the central coastal region. BARI has sites in six upazilas viz., Kalapara and Galachipa of Patuakhali district, Borguna Sadar and Amtali of Borguna district, and Charfassion and Lalmohon of Bhola district while BRRI works in Ujirpur and Bakerganj of Barishal district, Sadar and Nalcity upazilas of Jhalkati district, and Sadar and Nazirpur upazilas of Pirojpur district.

Coordination component, BARC: has been coordinating, supervising and monitoring the activities of other two components. In the reporting year, the component arranged a number of meetings, visited the sites at farmers' field, consulted with the sub-project personnel about the progress and problems of the sub-project works, and discussed improvements of the sub-project performances. Further, it has rendered advisory backstopping to the institutions' scientists in some relevant matters. The BARC component also attended a number of training programmes and field demonstrations arranged by BARI and BRRI components at their respective sites in the coastal regions.

BARI component: BARI component has fabricated six solar pumps each with 1300 Wp solar panels for irrigation and home appliances in six sites. One prototype model of solar irrigation and solar home system (SHS) was developed at the Farm Machinery and Postharvest Process Engineering (FMPE) Division, Bangladesh Agricultural Research Institute (BARI), Gazipur. The objective was to demonstrate similar prototypes at farmers' fields. But, before taking the technology to farmers' fields, two field experiments were conducted in the research field of FMPE Division, BARI, Gazipur for testing of the developed solar pump in furrow and drip irrigation systems during rabi season of first year in which results are incorporated in annual report. The same experiment is underway for the second year rabi season at the same field. With the results obtained from first year experiment at FMPE Division, BARI, the second year rabi season demonstrations in farmers' fields at the sub-project sites have been set with the crops tomato, brinjal and water melon of different varieties. Data on crops, soil and water salinity, solar radiation, pumps and accessories, solar home appliances etc. are being collected from each site. All the installed pumps and home systems are now operating well at farmers' level. A new solar home system was added to previously installed solar panels at Amtali site of Borguna district and data collection is underway. The vegetables in the farmers' fields are either



Brinjal field with drip system of irrigation

at vegetative stage or at fruiting stage and the water melon is at vegetative stage. Necessary crop management activities like intercultural operation, irrigation and associated activities are being done in the sites of the sub-project. Trainings were imparted to farmers, mechanics, electricians and Upazila Sub-Assistant Agriculture Officers. Each training was arranged including the participants from two sites. Thus, three batches of trainings for six sites have been completed in all the sub-project sites.

BRRRI component: Prior to setting up of solar systems at the sub-project sites, conducted some monitoring works during first year at field level to obtain information on existing irrigation practices and solar home system. The solar systems provided during second year for household purposes were subsequently transferred to Boro fields during 2019-2020 season. At this time, field experiments were set to test the performance of the solar pumps for rice cultivation in the selected locations. Collection of crop data was underway as the crops were in the field. The performance of solar pumps was tested at Bakerganj and Uzirpur Upazillas of Barishal district, Sadar Upazilla of



Field set up of flow meter and solar pump units

Jhalkati and Sadar Upazilla of Pirojpur districts. All the pumps generated flow rate above 30m³/h except one at Bakerganj Upazilla. The flow rates depended directly on the incidence of solar radiation which varied over times and dates. A field experiment at BRRRI, Gazipur was conducted prior to setting the systems at farmers' fields to develop a correlation between solar radiation and flow rate keeping a constant pumping head of 2 m. From the known solar radiation data, the flow rate (Q) could be estimated from the developed relationship for that particular head. This simulation provided the opportunity to calculate the hourly or daily total flow rates against solar radiation which could be delivered for a constant suction head, a given PV configuration and a definite pumping unit before installing the PV water pumping system in a given location. The site specific long term global horizontal irradiance (GHI), direct normal irradiance (DNI) and diffuse horizontal irradiance (DHI) data were collected from the Global Solar Atlas (<https://globalsolaratlas.info/>). Based on the GHI data, the maximum discharges were simulated from the developed equation. The highest discharge was found for Pirojpur Sadar Upazilla in March and the lowest discharge was found in May at Bakerganj Upazilla of Barishal district. The highest monthly average daily simulated discharge (232m³/day) was found in the month of March at Sadar and Nazirpur Upazillas of Pirojpur district and the lowest discharge was 171m³/day in the month of May at Bakerganj Upazilla of Barishal district.

2. Sub-project title: Groundwater resources management for sustainable crop production in northwest hydrological region of Bangladesh (ID 002)

Coordinator : Member Director (NRM), BARC, Farmgate, Dhaka

Implementing organization : BARI, BRRRI, and BINA

General objectives

- i. To assess groundwater availability and recharge pattern in different districts of northwest hydrological region of Bangladesh
- ii. To optimize groundwater abstraction for irrigation
- iii. To suggest plan for sustainable use of groundwater for crop productivity

Duration : February 2018 to June 2021

Budget : Tk.3,72,79,896/-

Background: The country's agriculture is responsible for more than 65 percent of total fresh water withdrawal, where nearly 80 percent of this irrigation water comes from groundwater resources. The contribution of groundwater has increased from 41% in 1982-83 to 77% in 2006-07. The ratio of groundwater to surface water use is much higher in northwestern districts of Bangladesh compared to other parts of the country. Climatically, this area belongs to dry humid zone with annual average rainfall vary between 1,400 and 1,900 mm. Though the groundwater dominates the total irrigated area, its sustainability is at risk in terms of quantity in the northwest region. Decline of groundwater in the central part, moderately declining trend in western, northwestern and northeastern areas during dry season is a threat of water resources for future. The substantial declination of groundwater level during the last decades causes threat to the sustainability of water use for irrigation in this region. If the over-utilization continues, it may result in its exhaustion after few years. So, emphasis should be given on the sustainability of these valuable resources. The PBRG sub-project (ID 002) has been coordinated by the Natural Resources Management (NRM) Division of Bangladesh Agricultural Research Council (BARC), with 3 components, namely Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) to assess groundwater availability and recharge pattern in northwest hydrological region.

Progress: The overall goal of this sub-project is sustainable management of groundwater resources through optimizing water demand and supply of the study region. The study locations were Rajshahi & Joypurhat under BARI (Component-1); Rangpur & Pabna under BRRI (Component-2) and Chapainawabganj and Naogaon districts under BINA (Component-3) of north-west region of Bangladesh.

Coordination component, BARC: Methodology and implementation strategy for the sub-project were developed at the beginning of the second year of the sub-project through series of coordination meetings. SoE, half yearly & yearly reports were edited, compiled and submitted. This component organized annual review workshop. Monitoring and evaluation activities of the sub-project were done as defined in inception report.

BARI component: Field work was initiated with a base line survey in two study areas: Rajshahi and Joypurhat. For collecting baseline information from the sub-project area, a structured questionnaire was developed and 25 farmers from each specified location were interviewed. The existing farming system, groundwater utilization, pricing system and problems in irrigation scheme, etc. were assessed through the survey work. The specified selected locations were Godagari and Tanore upazilas of Rajshahi and Joypurhat sadar and Kalai upazilas of Joypurhat district. Based on the survey results, a few location specific promising cropping patterns based field trials with rice and non-rice crops were conducted with adoption of water saving irrigation technologies in respect of the sub-project aim. Selection of site and farmers has been completed and as part of the cropping pattern based experiment, a number of field experiments with T.Aman rice, potato, mustard, wheat and boro have already been conducted in the selected locations. Meanwhile long-term (1980-2018) historical groundwater level data has been collected and prediction model has been developed by using discrete Space-state modeling approach for future forecasting of groundwater level. It is perceived that groundwater level declination in Rajshahi will be more than double (from 17.87 m in 2018 to 37.62 m in 2040) at all the three observation wells for the next 22 years if the present rate of abstraction continues. Groundwater abstraction pattern due to irrigation, domestic and municipal uses has been assessed and it is apparent that total abstraction will be increased by 33-35% in Joypurhat area and by 40-45% in Rajshahi area in the next 20 years. So, appropriate measures should be taken to ensure judicious use of water in all sectors especially in agriculture to protect the groundwater resources from being further depleted. The groundwater quality in the study areas has been evaluated for agricultural use. The water quality indices such as SAR, SSP, RSC, KR and WQI were calculated to find out its suitability for irrigation. In respect of all evaluating criteria, groundwater of the study area was found suitable and can safely be used for irrigation purpose. The increased and decreased recharge scenarios were computed using the existing groundwater pumping values in the year

2018. The three recharge scenarios considered was: (i) actual recharge, (ii) 90% of the actual recharge, and (iii) 110% of the actual recharge. The aquifer processes were simulated using a calibrated 3D finite difference based numerical simulation code MODFLOW. The results revealed that the computed groundwater heads at the three observation wells varied noticeably as a result of the changes in the recharge scenarios. The modelling tasks of the other three upazillas are continuing and will be included in the next report.

BRRRI component: During the sub-project period (March/2019-February/2020), all the experiments and activities have been performed in two upazilas (Ishwardi and Santhia) of Pabna district and two upzilas (Mithapukur and Pirgonj) of Rangpur district. All experiments have been conducted in farmer's field with the supervision of PI, Co-PIs and sub-project personnel. Secondary data have been collected from relevant sources for trend analysis of ground water table. Results revealed that among the four study locations the maximum declination of groundwater level occurred at Ishwardi among the locations. The highest average groundwater depletion 6.6 cm/year was also found at Ishwardi followed by 5.7 cm/year at Pirgonj,



Research field of wheat at Pabna

4.38 cm/year at Santhia and no groundwater depletion was observed at Mithapukur, Rangpur site. Analysis showed that the groundwater depletion rate could be retard by adopting water management technologies in Boro rice cultivation. Adoption of alternate wetting and drying (AWD) technology in 56.22% of total cultivated area in consecutive 5 years is able to bring groundwater table within suction limit. But it will take 10 years if AWD applied in 28.11% area. Combined application of AWD and PVC pipe water distribution could be saved the time and area coverage. Among the tested cropping patterns, T.Aman-Potato-Boro cropping pattern gave the highest rice equivalent yield and water productivity at Mithapukur, Pirgonj and Santhia site; and T.Aman-Lentil-T.Aus cropping pattern gave the highest yield and water productivity at Ishwardi site. AWD method was saved 16 to 39% irrigation water in the study locations. Supplemental irrigation during T.Aman 2019, could increase yield up to 36% over rainfed condition. Levee management during T.Aman, 2019 stored more rainfall and increased yield by 12% over farmer's management. All three filter media for suitable groundwater recharge method showed ability to reduce microorganism after filtration than source raw water.

BINA component: The cropping pattern study was completed and the results of economic analysis showed that all the introduced new cropping patterns yielded higher REY with reduced water compared to farmer's existing pattern (T.Aman – Fallow - Boro). The higher benefit-cost ratio and net income indicated the superiority of the improved patterns over the existing pattern. In case of groundwater recharge, from tracer technique, the yearly recharge was found as 243 mm, which is about 17.5 % of yearly rainfall. From water balance method, the yearly recharge was found as 149.1 mm, which is about 10.7 % of yearly rainfall. The patterns of yearly maximum and minimum water-table at Nachole and Niamatpur revealed that, the magnitude between maximum and minimum depth to water-table is decreasing over time, meaning that the recharge rate is decreasing. The total budget of the project is Tk. 3,72,79,896/- (Taka three core seventy two lac seventy nine thousand eight hundred and ninety six only). Budget for Coordination Component: BARC is Tk. 77,74,921, Component-1: BARI is Tk. 1,15,21,880, Component-2: BRRRI is Tk. 1,04,20,025 and Component-3: BINA is Tk. 75,63,070.00



Water flow meter for discharge measurement

respectively. Out of total allocated budget, component institutes have received during reporting period: BARC Tk. 32,45,500.00, BARI Tk.67,20,023.00, BRRI Tk. 55,64,395.00 and BINA Tk. 38,66,249.00, respectively; and expenditure of BARC Tk. 32,07,153.00, BARI Tk. 59,46,194.00, BRRI Tk. 49,75,889.00 and BINA Tk. 38,54,502.00, respectively.

3. Sub-project title: Transfer of agricultural technologies to farmers' level for increasing farm productivity (ID 005)

Coordinator : Director, TTMU, BARC, Farmgate, Dhaka
Implementing organization : BARI, BINA, BSRI, BLRI, BFRI, SRDI, CDP, BJRI, BRRI, BWMRI
General objective : To transfer NARS institutes generated economically viable technologies rapidly for higher agricultural productivity and profitability with solving problems at farmers' level

Duration : May 2018 to June 2021

Budget : Tk 3,24,60,000/-

Background: Every year 13 NARS institutes are performing different researches on agricultural development of the country. BARI, BRRI, BJRI, BSRI, BLRI, BFRI, FRI, BTRI, BSRTI,SRDI, BINA, BWMRI and CDB innovate technologies on rice, jute, sugar crops, livestock, fisheries, forest, tea, sericulture, soil, crops, wheat and cotton respectively. Numbers of matured technologies from different NARS institutes have been transferred through the National Agricultural Coordinating Committee (NATCC) meeting to DAE, DLS, DoF for dissemination in different ways (demonstration, training, workshop, publication, newspaper, fair, rally, social media. etc.) but the adoption rate is low. Some of matured or promising important technologies are still not using in field needs to transfer at farmers' level. So, immediate transfer of technology at farmers' level is needed for farm productivity enhancement. The procedures of popularization of these technologies to the farmers, researchers and end users need to follow appropriate, economic and effective ways. Agricultural productivity could be increased significantly by transferring technologies rapidly.

Technology transfer related research information mainly the proper transfer way from all the NARS institutes to farmers level needs to be analyzed. So, it is a burning issue to invent the ways of transferring technology economically. With this view in mind, the present research has proposed to analyze the rapid transferring modeling of technologies from all NARS institutes in Bangladesh for farm productivity enhancement. The sub-project proposal for Program Based Research Grant (PBRG) was submitted by the coordination of the Technology Transfer and Monitoring Unit (TTMU) of Bangladesh Agricultural Research Council (BARC) and a Letter of Agreement (LoA) was signed on 11 July, 2018. The Field activity was done in ten sites: Manikganj site under BJRI component, Tangail by SRDI, Mymensingh (Sadar Upazila) by BINA, Sirajganj (Sadar Upazila) under BSRI component, Mymensingh (Bhaluka and Muktagacha Upazila) by BRRI, Sirajgong (Shahjadpur Upazila) by BLRI, Bandarban site under CDB component, Shariatpur and Barishal by BARI component, Sherpur site under BFRI component and Dinajpur, Thakurgona and Panchagar districts by BWMRI.

Coordination component, BARC: Coordination Component has coordinated with 10 institutes to transfer NARS institutes generated economically viable technologies rapidly for higher agricultural productivity and profitability with solving problems at farmers' level. Annual Review Workshop for the sub-project was organized on 02 October, 2019 with the participation of scientists, professional, specialist, PIs and Co-PIs of respective component. Comments and suggestions made in the Annual Review workshop was compiled and sent to the respective components. On the other hand a coordination meeting was arranged on 05 December, 2019 with the active participation of all 10 components. Discussions and suggestions of the coordination meeting were

compiled as proceedings and also sent to the concerned components for necessary action. Sub-project activities of all 10 components are being monitored by the coordination component. Field monitoring activities were done in all the ten sites by the personnel of coordination component with the leadership of the Coordinator. TTMU constructed a questionnaire to assess the data base scenarios of transferred and non-transferred technologies generated by the researchers from the inception of 10 NARS institutes mentioned above. Three enumerators were recruited to collect technology related information from these 10 NARS institutes. Information from CDB, SRDI, BSRI, BJRI, BRRI, BFRI and BINA has already been collected. Data entry is going on for analysis. Collection of the technology related information of the rest 2 institutes (BARI and BLRI) is going on.

BWMRI componen: As per programme there were 7 locations viz. Haripur and Pirgang upazilla in Thakurgon district, Tetulia and Atwari upazilla in Panchagar district, Kaharol, Shetabgonj and Sadar upazilla under Dinajpur district but practically 12 farmers of those locations were selected for seed production and to demonstrate complete production technology to the farmers. Major cropping pattern in sub-project areas were 1) T. Aman-Wheat-Maize, 2) T. Aman-Wheat- Mungbean, 3) T. Aman-Wheat- Jute, 4) T. Aman-Wheat-Boro rice (BRRI dhan28), 5) T. Aman-Potato-Wheat-Maize, 6) T. Aman- Wheat- Fallow. Four farmers from Atwari Upazilla, three farmers from Tentulia Upazilla and Single farmer from other upazillas were selected. BWMRI released high yielding and disease resistant varieties (BARI Gom-29, 32, 33 and WMRI Gom-1) were selected for disseminating to the farmers for increasing their economic benefit. A total of 15 acres land was planted with 4 wheat varieties. 12.5 acres were planted at optimum seeding time and 2.5 acres were planted after early potato harvest (Third week of December). Recommended doses of fertilizer and other management practices were done in proper time. Initial germination and crop growth were excellent. Visitors from TTMU-BARC, CIMMYT and Agriculture Ministry had visited the experimental fields. All the trials were harvested at the end of March to 1st week of April. Yield of those



Demonstration plot at Kaharoleupazilla, Dinajpur

farmer's trials were varied from 4 tons to 4.8 tons per hectare. Wheat based four cropping pattern was profitable in these area. Around 7 tons seed of BARI Gom -33 were collected from those farmers by the Bangladesh Wheat and Maize Research Institute (BWMRI) for next year use as a quick dissemination of wheat blast resistant variety.

BARI component: has selected Shidda village of Dmmuda Upazila; Nagerpara, Idilpur and Tin Khamba villages under Gosairhat Upazila of Shariatpur district; Kazirchar and Saidergao union under Muladi Upazilla in Barishal district for setting experiments on BARI released fruit varieties at farmer's level and demonstration of improved modern technologies of different important major and minor fruit cultivation practices. The important fruits are mango, litchi, banana, lemon, guava, dragon fruit, ber, Burmese grape, aonla, carambola, malta, coconut, pummelo, wax jambu, golden apple etc. The average plot size of 28 decimal in Dammuda upazila and 33 decimal under Gosairhat Upazila in Shariatpur district whereas the average plot size of 35 decimal under Babuganj Upazila and 50 decimal under Muladi Upazila in Barishal district. All targeted farmers were selected (those have 25 to 33 decimal of land) and fruit saplings were distributed last year among 60 farmers of Damudda and Gosairhat Upazilla in Shariatpur district and 60 farmers of Muladi and Babuganj Upazilla in Barishal district as well as 50 fruit saplings were also distributed to each selected farmer of Damudda and Gosairhat Upazillas in Shariatpur district. Last year (29/05/19) 50 plants have given to each farmer. After preparation of pit with organic and chemical fertilizers fruit saplings were planted. Necessary

intercultural operations are being practiced as per recommendation of BARI. The plants are in vegetative stage and present growth conditions of the plants are good. Moreover, a socioeconomic survey has been conducted in first year to know the present livelihood status of the farmers and to find out the problems and potentials of the households.

BINA component: BINA conducted cropping pattern trials to replace the existing one through improved one with modern varieties released recently. BINA introduced two new cropping patterns one in Sadar, Mymensingh like early T. aman " Mustard " late Boro against the existing T. aman" fallow" Boro cropping pattern; and another one in Madhukhali, Faridpur like early T. aman " Lentil " Aus against T. aman " fallow/onion " Jute/Sesame cropping pattern. BINA conducted experimental trials in aman season with T. aman rice (var. Binadhan-7 and Binadhan-11) at two locations as per the work plan and activity schedule. Binadhan-7 and Binadhan-11 was transplanted at Sadar, Mymensingh from 17-26 August, 2019 and at Madhukhali, Faridpur from 16-17 August, 2019 respectively. In Sadar, Mymensingh T. aman was harvested on 7-19 November 2019, yield of Binadhan-7 and Binadhan-11 were 4.88 and 5.58 t/ha with the average maturity period of 107 and 109 days, respectively. In Madhukhali, Faridpur T. aman with same variety were harvested on 15-16 November 2019, yield of Binadhan-7 and Binadhan-11 were 4.29 and 5.05 t/ha with the average maturity period of 115 and 116 days, respectively.



T. Aman Binadhan-11 at Mymensingh during 2019-20

In rabi season, Binasharisa-9 was sown at Sadar, Mymensingh from 23-27 November, 2019 and Binamasur-8 was sown at Madhukhali, Faridpur from 7-17 December, 2019. Binasharisa-9 produced average yield of 1.61 t ha⁻¹ with the average maturity period of 85 days. On the other hand, Binamasur-8 produced average yield of 2.04 t ha⁻¹ with the average maturity period of 99 days. In boro season of 2019-2020, Binadhan-10 was transplanted at Sadar, Mymensingh from 18-27 February, 2020. Binadhan-10 is near ripening stages up to the reporting period. In aus season of 2019-2020, Binadhan-19 and Binadhan-14 was broadcasted at Madhukhali, Faridpur from 10-15 April, 2020. Binadhan-19 and Binadhan-14 is now in vegetative stage.

BSRI component: The aim of BSRI component is to transfer chewing and gur varieties of sugarcane among the participating farmers for increasing yield through sugarcane with intercropping for raising their economic benefit. As per programme, four locations were selected i.e. Sirajgonj district (Sirajgonj Sadar, Kazipur, Raigonj and Tarash Upazilla) for the transfer of BSRI released latest modern sugarcane varieties BSRI Akh 42 and BSRI Akh 45 with the help of UAO and SAAOs. Five farmers were selected in each selected location. So, total no. of farmers is 20 and total demonstration area is about 20 bighas. Twenty demonstration plots of BSRI Akh 45 (gur) and BSRI Akh 42 (chewing) were established. Potato (Diamond/ Cardinal) and Mungbean (BINAmug 8) were planted as intercrop. Sugarcane sets/settlings and recommended doses of fertilizer and other management practices were done in proper time. The highest tiller was found in gur varieties than chewing cane in early plantation of both cases. Overall crop condition is excellent.



Chewing cane (BSRI akh 42) in the project area

BLRI component: BLRI conducted validation trials on the technology entitled 'Preservation of green grasses/fodder through silage' in the farmers' field of Shajadpur (Sirajgonj) and Godagari (Rajshahi). Baseline survey was conducted among 150 farmers in two locations. The education level of farmers was 8% illiterate, 82% primary level and 9% secondary level. The family member of male was below 18 years having 1.61 number per family and over 18 years 2.0 number per family. The female were below 18 years with 1.57 number per family and over 18 years 1.74 number per family. The land use such as housing area were 50 decimal, cultivated area 95 decimal, uncultivated area 08 decimal and fodder land area 20 decimal per family. Thirty selected farmers were provided training on fodder cultivation and silage technology. Perennial high yielding fodders like Napier stem cutting (Var. BLRI Napier 1, 4) were planted in November/2018. First cut was made 60 days after the establishment with biomass yield at Shajadpur and Godagari were 27 t/ha and 26 respectively. The total fertilizer cost (Tk/ha) for fodder production of Shajadpur and Godagari were Tk. 15856/- and Tk. 16344/- respectively. The major problem faced by the farmers were lack of fodder, lack of grazing land, high price of concentrate feed etc in rainy season. Existing feeding cost of dairy cow (300 kg bwt) in rainy season is Tk. 216/d, where concentrate Tk. 108 and straw Tk. 108. Preparation cost of 1000 kg dole silage is Tk. 2725 and thus production cost per kg silage is Tk. 2.73. Introduction of dole silage in the feeding system will reduce the feeding cost of the dairy farmers in rainy season.



Silage preparation by farmers

BFRI component: BFRI has selected Gorddar village under Nakla Upazilla, Sherpur district. Trials entitled Validation and Demonstration of Culture of Pabda (Ompok pabda), Gulsha (Mystus cavasius) with Rui (Labeo rohita), and Demonstration of Culture of Shing (Heteropneustes fossilis) with Rui (Labeo rohita) and Catla (Catla catla) in farmer's pond were demonstrated in 05 farmers pond. In July 2019, five ponds were selected with the consultation of Upazilla Fishery Officer, Nakla. The selected ponds were prepared with lime and fertilizers. After preparation, 03 ponds were stocked with Pabda, Gulsha and Rui at the stocking density of 125000, 50000 and 1250/ha. While, another 02 ponds were stocked with fingerlings of Shing with Rohu and Catla were stocked in ponds at a stocking density of 175000, 750 and 750/ha, respectively. Fishes were fed with supplementary floating feed containing 30% crude protein. For maintaining suitable water quality, ponds were treated with lime at the rate of 25.0 kg/ha at fortnightly interval. After five months rearing, the harvesting weight of Pabda, Gulsha and Rui were 40-45g, 33-39g and 709-780g respectively. While in Shing culture ponds, the Shing reached harvesting weight 45- 48g with the average production of 908 kg.

SRDI component: validated Upazila Nirdeshika based balanced fertilizer application technique in Boro-Fallow-T. Aman cropping pattern in the selected farmers fields of Cumilla and Tangail for improving existing farmers' practices for increasing farm productivity. Focus Group Discussions (8) were arranged to motivate the farmers about using soil test status based fertilizer dose in Boro (BRRIdhan58)-Fallow-T. Aman (BRRIdhan72) pattern. BRRIdhan recommended cultural practices were followed except fertilizer dose. Fertilizer doses were calculated on the basis of soil test status given in respective updated Upazila



Seedbed of BRRIdhan 58 (Bhuapur)

Nirdeshika following FRG 2018, BARC. In 2018-19 Adaptive trial and control plots with BRRIdhan72 were established in T. Aman season. Moreover 4 Farmers each from 4 Upazila were provided with 5 kg seeds and recommended fertilizer doses for application in BRRIdhan72 in T. Aman season. In Tangail Sadar Upazila, yield of BRRIdhan72 in adaptive trial plot was 5.37 t/ha while in control plot the yield was 5.16 t/ha. It was observed that yield in motivated farmers plot varied from 4.75 to 5.47t/ha. On other hand in Bhuapur Pouashova, yield of BRRIdhan72 in adaptive trial plot was 5.16 t/ha and in control plot yield was 4.73 t/ha. Yield in motivated



Balanced fertilizer application at farmers field (Bhuapur)

farmers plot varied from 4.9 to 5.23 t/h. In Sadar Dakshin Upazila of Cumilla, the yield of BRRIdhan72 in adaptive trial plot was 5.88 t/ha while in control plot yield was 5.23 t/ha. Among the 4 motivated farmers plots yield was ranged from 4.25 to 4.56 t/h. In Burichong Upazila (Cumilla), yield of BRRIdhan72 in adaptive trial plot was 5.16 t/ha while in control plot yield was 4.73 t/ha. Among motivated farmers plot yield was varied from 4.11 to 4.55 t/h. Field days were organized in each upazila in T. Aman season involving 30 farmers of the locality, DAE & SRDI personnel and crop cutting was done by BBS personnel following standard method.

In 2019-20 Adaptive trial and control plots with BRRIdhan58 were established in Boro season. Moreover 4 Farmers each from 4 Upazila were provided with 5 kg seeds and recommended fertilizer doses for application in BRRIdhan58. In Tangail Sadar Upazila, yield of BRRIdhan58 in adaptive trial plot was 7.25 t/ha while in control plot it was 6.5 t/ha. Yield in one motivated farmer plot was 6.5 t/ha. On the other hand In Bhuapur Pourashova, yield of BRRIdhan58 in adaptive trial plot was 7.7t/ha while in control plot yield was 6.5 t/ha. In Sadar Dakshin Upazila (Cumilla), the yield of BRRIdhan58 in adaptive trial plot was 7.0 t/ha while in control plot yield was 6.5 t/ha. Among 4 motivated farmers plot yield of BRRIdhan58 varied from 5.92 to 7.0 t/h. In Burichong Upazila (Cumilla), yield of BRRIdhan58 in adaptive trial plot was 7.0 t/ha while in control plot yield was 6.0 t/ha. Among 4 motivated farmers plot yield was ranged from 5.9 to 6.5t/ha.

CDB component: Recently, CDB has generated 4 technologies those are a) CB-14 variety, b) application of mepiquat chloride, c) removal of vegetative branches and d) de-topping at 90 DAS (Day after sowing). These four technologies have the potentiality to increase per hectare yield. . CB-14 is a disease resistant full-season variety with high yield potential (4-5 t/h) better than existing varieties and with high fiber quality. Four sprays of Mepiquat chloride, at the rate of 1.75 ml/10 liter of water starting from 30 days after germination at 15 days interval, suppress excessive plant growth and increase cotton yield (25%) over control. In the first year, field trials (Demonstration) were conducted on 13 farmers field under 3 Zonal offices of CDB. Four field trials were conducted at Thakurgoan and khagrachari zone and 5 field trials were conducted at Bandarban Zone. Necessary intercultural practices, fertilizer and pesticide application have been done in 13 field trials. Crop has already been harvested and the results showed that the CDB generated technologies has increased per hectare yield and are found more profitable.

BJRI component: The main target of BJRI component is to transfer the BJRI developed high yielding variety of Tossa jute BJRI Tossa Pat-8 (Robi-1) and BJRI Kenaf (HC-95) of jute and allied fibre crops, which have potentiality to increase crop yield and economic benefit to the farmers. Recent released varieties along with other technologies like line sowing method, recommended fertilizer doses, weed management, pest and disease control were demonstrated at farmers' level. Base line survey was done following a structured questionnaire. A total of 36 farmers were selected from 3 locations i.e., Manikganj, Rangpur and Faridpur for

baseline survey. Information related to socio economic condition, agricultural activities and jute and jute seed cultivation was recorded. Farmers' orientation by FGD was arranged on jute and jute seed production technologies. By the orientation program farmers were introduced about BJRI technologies on jute and jute seed production. As per program two locations (Manikganj and Rangpur) were selected for seed production in the second year. Seed crop production was conducted at Manikganj and Rangpur in the last part of August and 1st week of September'2019 respectively. Six (6) farmers were engaged in both the locations for seed production



Variety demonstration plot

program. All improved techniques of seed production like direct seeding and line sowing method, recommended fertilizer doses, weed management, pest and disease control measures were applied in each field. In total 365 kg seeds were produced from 124 decimal land at Manikganj (201kg) and in Rangpur (164 kg) under the program. Demonstration of the variety Robi-1 was conducted at Faridpur and Rangpur for fibre. Eight (8) farmers were involved in variety demonstration program from each location. The variety BJRI Tossa Pat-8 (Robi-1) and BJRI Kenaf (HC-95) along with other technologies like line sowing method, recommended fertilizer doses, weed management, pest and disease control measures have already demonstrated at farmers' field. The improved retting technique of jute will be demonstrated at farmers' level after harvesting of green jute plant. Crop production status (Fibre and stick yield) will also be reported after completion of crop harvest. The crop will be harvested at July/August.

BRRRI component: Demonstration was conducted with the latest BRRRI released rice varieties both in T. aman 2019 and Boro 2020 season. Four locations i.e. Valuka & Muktagacha upzillas of Mymensingh and Sadar & Sarishabari upzillas of Jamalpur were selected for the demonstration of BRRRI released latest modern rice varieties with the help of UAO and SAAOs. Six farmers were selected in each selected location having total no. of farmers was 24. Total demonstration area was about 24 bighas (6 bighas x 4 locations). Seeds of T. aman rice varieties e.g. BRRRI dhan70, BRRRI dhan71, BRRRI dhan75, BRRRI dhan79, BRRRI dhan80 and BRRRI dhan87 were supplied to the selected farmers. Beside, recommended fertilizers were supplied to the farmers. Seed beds preparation were completed by July/2019 and transplanting was completed by August/2019. Different cultural management practices were done as per requirement. Finally crop cut were done and harvested data and others data were collected. The average yield of the latest BRRRI released T. aman rice varieties e.g. BRRRI dhan70, BRRRI dhan71, BRRRI dhan75, BRRRI dhan79, BRRRI dhan80 and BRRRI dhan87 were 4.54, 5.07, 5.01, 5.02, 4.56 and 6.02 t/ha respectively. Among the rice varieties, BRRRI dhan87 produced the highest grain yield 6.02 t/ha followed by BRRRI dhan71 (5.07 t/ha), BRRRI dhan79 (5.02 t/ha) and BRRRI dhan75 (5.01 t/ha). However, the yield of BRRRI dhan87 varied from 5.89 to 6.13 t/ha in different locations depending on soil fertility, cropping pattern and management practices. However, the lowest grain yield (4.54 t/ha) was found in BRRRI dhan70 and the 2nd lowest grain yield (4.56 t/ha) was found in BRRRI dhan80. The average growth duration of BRRRI dhan70, BRRRI dhan71, BRRRI dhan75, BRRRI dhan79, BRRRI dhan80 and BRRRI dhan87 were 132, 116, 116, 143, 134, & 129 days respectively. The highest grain yielder BRRRI dhan87 has the intermediate duration (129 days). Total grain production of BRRRI dhan70, BRRRI dhan71, BRRRI dhan75, BRRRI dhan79, BRRRI dhan80 and BRRRI dhan87 were 2432 kg, 2718 kg, 2683 kg, 2686 kg, 2441 kg and 3221 kg respectively. The highest total paddy production (3221 kg) came from BRRRI dhan87 and the lowest total paddy production (2432 kg) came from BRRRI dhan70. The retained seeds by the participant farmers of BRRRI dhan70, BRRRI dhan71, BRRRI dhan75, BRRRI dhan79, BRRRI dhan80 and BRRRI dhan87 were 410 kg, 520 kg, 445 kg, 430 kg, 470 kg and 602 kg respectively. Grand total of six rice varieties regarding to grain production was 16,181 kg from which farmers retained 2877 kg as seed for the next year cultivation. A considerable number of farmers observed the performance of the

six BRRI released recent rice varieties and among them 642 farmers were motivated for the next year cultivation.

In the Boro season of 2020, demonstration was done by of BRRI released latest modern Boro rice varieties e.g. BRRI dhan58, BRRI dhan67, BRRI dhan81, BRRI dhan84, BRRI dhan88 and BRRI dhan89 in the same locations in 24 bighas of land (6 bighas x 4 locations). Rice seeds and fertilizers were already supplied to the selected farmers. Seed beds preparation were completed by December/2019 and transplanting was completed by January/2020. Different cultural management practices were done as per requirement. All the rice varieties were not matured yet (up to 15 May, 2020), only short duration rice varieties i.e., BRRI dhan81, BRRI dhan84 and BRRI dhan88 were matured and the results of these 3 short duration rice varieties in the demonstration sites are mentioned. The average yield of the latest BRRI released Boro rice varieties e.g. BRRI dhan81, BRRI dhan84, BRRI dhan88, were 5.45, 5.53 and 6.13 t/ha respectively. Among the rice varieties, BRRI dhan88 produced the highest grain yield 6.13 t/ha followed by BRRI dhan84 (5.53 t/ha) and BRRI dhan81 (5.45 t/ha). However, the highest grain yielder BRRI dhan88 grain yield varied from 5.94 to 6.33 t/ha in different locations depending on soil fertility, cropping pattern and management practices. The average growth duration of BRRI dhan81, BRRI dhan84 and BRRI dhan88 were 141, 141 and 143 days respectively. The highest grain yielder BRRI dhan88 growth duration was 2 days longer than the rest 2 rice varieties. Total grain production of BRRI dhan81, BRRI dhan84 and BRRI dhan88 were 2918 kg, 2962 kg and 3281 kg respectively. The highest total paddy production (3281 kg) came from BRRI dhan88 and the lowest total paddy production (2918 kg) came from BRRI dhan8. Participant farmers retained seeds of BRRI dhan81, BRRI dhan84 and BRRI dhan88 were 520 kg, 586 kg and 625 kg respectively. Grand total of three rice varieties regarding to grain production was 9161kg from which farmers retained 1731 kg as seed for the next year cultivation. A considerable number of farmers (598) observed the performance of the three BRRI released recent rice varieties and among them 303 farmers were motivated for the next year cultivation.

4. Project Title: Value addition and standardization of nutritional level in selected food items from animal and plant origin (ID 007)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka
Implementing organization : PSTU, HSTU
General objective : Finding out the ways of producing poultry and poultry products for safe human consumption for mitigating malnutrition by identifying the health-hazards materials in poultry industry and their effects on nutritional quality of poultry and poultry products

Duration : Apr 2018 to Jun 2021

Budget : Tk 3,49,16643/-

Background: Consumption of chemically treated and/or adulterated foods those causes various serious diseases (like cancer, asthma, ulcer, etc.) has become a threat for the national health. Fish, meat, milk and their products including processed foods are also adulterated in different stages of processing and marketing. Food safety nowadays has become an important topic in Bangladesh as consumers of the country have become victim due to serious adulteration in food. Poultry meat and eggs are the two popular and easy-to-afford protein sources to the people. Most of the chemicals and veterinary drug residues, either from feed or other exogenous uses, in animal foods may have some noxious effects on human health. Like fruit and vegetables, the use of health-hazard materials in livestock and poultry products became a serious issue in Bangladesh in the recent years. But, their usages are not been controlled. Under these circumstances, poultry

feeds and poultry products need to be analyzed. Efforts should be given to identify the extent and steps of use of the hazardous materials, chemicals and their derivatives, and microbial contamination in poultry feed and their residual effects in raw and value added poultry products. The research initiatives under the PBRG sub-project were initiated with a goal at ensuring safe and nutrient enriched food production from poultry sources for increasing human nutrition intake.

PSTU component: Findings of the layer trial during winter indicate that environmental factors had a significant influence on weight gain and feed intake rather than feed composition. Survivability was almost similar in all treatment groups. Delayed sexual maturity beyond breeder's recommendation in various dietary treatment groups is difficult to explain. During trial period, a known fresh egg sample containing therapeutic dose of Tylosin was exposed to laboratory quantification and found no residue of Tylosin in eggs. Except one feed, broilers' weight gain was not affected much by type of feed. Maintaining appropriate in-house temperature and avoiding gas accumulation were the challenges during winter months. Laboratory reports indicate that Arsenic concentrations in some raw Liver samples were beyond MRL level and the higher concentrations of Arsenic was derived from feed sources. Arsenic and Maduromycin levels in raw breast muscles were below MRL. Similarly, Chromium, Led, Arsenic and Maduromycin levels in raw drumstick muscle samples were below MRL and safe for human consumption. Awareness meeting was organized in Babuganj and Uzirpur upazila to disseminate the poultry production techniques among the farmers and dealers for safe poultry meat and egg production.



Layer Shed during winter trial

In current fiscal year total 450 growing pullets of 14-week age were divided into five dietary treatments groups having three replications each. Each replicate group possessed 30 birds. Birds were penned on a slatted floor by adjusting the average body weight. Standard management practices were provided. Dietary treatments (Diet 01, 02, 03, 04 and 05 were selected based on earlier feed analysis data). Body weight at the end of 28-week differed significantly although controlling body weight was tried to achieve target body weight during the entire study period. The highest weight was recorded in diet 01 group and the lowest in diet 02. This could be due to lower feed intake related to health issues. However, finally amount of feed consumption in all treatment groups were successfully controlled as recommended by the breeder.

Table 3.4: Effect of dietary treatments on the growth performances

Parameter	Dietary treatment				
	Diet 01	Diet 02	Diet 03	Diet 04	Diet 05
Initial BW at 15-week (g)	1244.13	1265.54	1275.08	1277.75	1262.71
Final BW at 28-week (g)	2134.12	1951.06	2073.59	2017.53	2106.08
Feed consumption at 16-week (g/b/d)	70.82	66.97	63.06	66.05	66.02
Feed consumption at 28-week (g/b/d)	111.89	109.75	110.36	110.59	109.92
Survivability (%)	100.00	100.00	100.00	100.00	97.50

Bird fed diet 02 attained sexual maturity at 139 days which significantly lower than other dietary treatment groups (Table 3.4). Obtaining first egg from Diet 02 group was delayed by about two weeks as recommended by the breeder. Birds in all dietary groups achieved 50% egg production in similar age except Diet 01. Findings also indicate that only birds on Diet 05 attained peak egg production almost on an age recommended by the breeder.

HSTU Component: The HSTU component engaged in to identify the health-hazards materials in poultry industry and their effects on broiler meat and meat products and to find out the ways of producing quality or safe poultry meat for food for human consumption. Some general and specific objectives were set to achieve this goal. These objectives will be fulfilled through identifying chemical hazards in poultry feed, and poultry-origin chain and also indicating the means of sidestepping their ill-effects. Commercial broiler feeds was collected from a variety of manufacturers producing huge lot, medium one and small units situated in Bangladesh. Samples were analyzed for identifying and quantifying the chemical hazards and toxic minerals, and nutritive content. After finding laboratory result 6 feed samples were selected for identifying further effect of growth performances of broiler, carcass characteristics and residual effect of meat and meat products is still to measure through a serious of trials.



Broiler rearing in winter season

A study was conducted to know the effects of different house feed on body weight change of broilers and meat quality at HSTU. Total 180 broilers of 28-day old were divided into three fed (diets) having three replicates each. Two market/house feeds (Paragon and AIT) were compared with a standard known A1 Broiler finisher diet for period of 7 days. These market feeds were subjected to laboratory analysis for determining nutritive contents and chemical hazards before the commencement of the trial. Results indicated that weight gain and feed conversion were significantly affected by diets that could be due to differences in final body weight although amounts of feed consumption were almost similar. Live carcass weight also affected, breast meat, skin and shank weights of slaughtered birds. Birds fed standard finisher diet gained apparently much higher live weight (1766.67g) compared to those fed different market feeds (1600.67 and 1546.67) at the end of 35-day of age. On the other hand, FCR also so higher in case market feed compare to broiler finisher feed. In case of carcass characteristics there is no significant different between dressing percentage, thigh meat, gizzard and liver weight.

Table 3.5: Effect of different house feed on production performance of broiler

Parameter	Dietary treatments		
	T ₁	T ₂	T ₃
Initial live weight at 4 th week of age (gm)	1402.33±62.60	1427.60±75.72	1345.33±38.92
Final body weight at 5 th week of age (gm)	1766.67±26.67	1600.67±50.44	1546.67±13.33
Body weight gain (gm)	392.34±30.2	172.4±18.77	201.34±24.54
Feed intake (gm)	827.5±22.32	703.33±20.33	810.00±12.50
Feed efficiency	2.10±0.22	4.08±0.32	4.02±0.26

T1 = commercial broiler feed, T2= house feed 1, and T3= House feed 2

5. Sub-project title: DNA marker-assisted breeding for producing highly stress tolerant elite rice varieties for coastal Bangladesh by introgression of multiple salt tolerance loci (QTLs) into commercial cultivars (ID 010)

Coordinator : Director Research, BRRI, Joydebpur, Gazipur-1701
Implementing organization : BRRI, DU
General objective : To establish a fluorescent-based quick and easy system for target allele in a breeding program

Duration : April 2018 – March 2021

Budget : Tk.1,41,83,075/-

Background: Bangladesh is both one of the biggest producers and largest importers of rice in the world. Rice is not only a major staple food for millions of Bangladeshi but also contributes most of the total calorie intake (HIES, 2010). Bangladesh has a land area of 148 million hectares (Mha) and a population of over approx. 166 million with a density of 1128 persons per km². The population is going to grow about 200 million by 2050. Rice production will reduce by 14% than demand by 2050 (Kirby et al., 2016). Bangladesh is a country of high population density, wrapped up by natural disasters like floods, cyclones as well as tornadoes. Moreover it has scarcity of natural resources and persistent poverty. Even though it has attained food security in recent years with the self-sufficiency in rice, more is needed for the rising population. This is particularly true for stress-prone areas like the South, where subsistence farmers are able to grow only a single annual crop of rice. According to the Bangladesh Bureau of Statistics (BBS, 2013); rice is produced on nearly 77% percent (11,528,261 Hectares) of total cultivated land in all three seasons in Boro (in the dry season of November- May), Aman (in the main monsoon season of July-December) and Aus (in the early summer season of April-August) in all eight divisions of the country. BRRI scientists have already developed 81 modern rice varieties with diverse properties. However, by tackling various problems, particularly stress-prone zones, additional rice production in fallow lands can help in increasing rice productivity and can be one of the strategies for the country to reduce poverty and achieve its food security goals in target areas (BRRI, 2014; Regmi *et al.*, 2016)

Progress: Breeding rice for salinity tolerance together with high yield is difficult as the traits are controlled by multiple genes. Moreover, salt tolerance has to be ensured at both seedling and reproductive stages. Introgressing multiple QTLs conferring salinity tolerance at the two stages into high yielding rice background is planned to address the problems. Even so, ensuring the introgression of multiple loci is difficult without DNA-based high-throughput markers like SNPs. We developed RILs (Recombinant Inbred Lines) with salt tolerance QTLs for root length (RL, seedling stage), potassium (K⁺, seedling stage) and filled grain number with spikelet fertility (FGN+SF, reproductive stage).



Hybridized plants of back crossing during boro 2019-20

Another established QTL 'Saltol' is also available in the RILs. We want to introgress those QTLs into the background of high yielding BRRI dhan63, BRRI dhan67 and BRRI dhan74 using 'Fluorescent-based KASP' (Kompetitive Allele Specific PCR) markers, having advantage of identifying the specific alleles through real time PCR (Polymerase Chain Reaction) without running gel electrophoreses. Hybridization followed by generation advancement and DNA marker-based Fluorescent selection are carrying at Bangladesh Rice Research Institute (BRRI) and Dhaka University (DU), respectively. The activities involving multiple crosses and selections are expected to need at least four generations requiring three years. At the end of the sub-project, we hope to develop a few advanced breeding lines having relatively higher salt tolerance (8-10 dS/m for both stages of growth) with higher yield compared to already bred varieties. Hybridization between salt tolerant donor RILs, I-14 and I-71 and recipient high yielding cultivars has been done during 1st year of sub-project

period. We derived F1s from crosses among donor and recipient parents. Furthermore, double cross was made between those F1s. Using three recurrent parents, a total of 38 double crossed F1 plants were selected against seven foreground (QTL specific) markers. In this year the selected 38 double crossed F1s were backcrossed with recipient parents BRR1 dhan63, BRR1 dhan67 and BRR1 dhan74. A total of 906, 505 and 363 BC1F1 seeds were produced using recurrent parents BRR1 dhan63, BRR1 dhan67 and BRR1 dhan74, respectively. Seventeen BC1F1 plants with positive alleles (four QTLs) were selected from all cross combinations using eight foreground (QTL specific), seven recombinant and 48 background markers. The selected BC1F1 plants had 13.7 to 31.7% of background recovery over 48 background markers. From these selected plants, total 2341, 1648 and 528 BC2F1 seeds were produced using recurrent parents BRR1 dhan63, BRR1 dhan67 and BRR1 dhan74, respectively. A total of 272 KASP makers have been tested. Out of 272, eight foreground, nine recombinant and 78 polymorphic background markers were identified.

6. Project Title: Food-based initiative for improving household food security, income generation and minimize malnutrition (ID-011)

Coordinator	:	Member Director (Fisheries), BARC, Farmgate, Dhaka
Implementing organization	:	BLRI, NSTU
General objective	:	identify the present socio-economic situations and livelihood pattern of the ethnic and coastal people by studying pattern and biological productivity of homestead resources (livestock and fisheries) with a view to increase food security and adequate dietary intake in terms of energy, protein, fat, vitamin and other micronutrients
Duration	:	Apr 2018 to Mar 2021
Budget	:	Tk. 74,16,980/-

Background: Fish, meat, milk and their products including processed foods are also adulterated in different stages of processing and marketing. The foods of animal origin also adulterated by mixing or adding non-food ingredients, using preservatives, additives, coloring, flavoring chemical adulterants. Rice grain contaminated due to heavy metal contamination, pesticide contamination, fungal colonization and mycotoxin contamination, which may affect the public health. Significant improvements in food consumption and behavior have also been observed since 1992, with per capita daily calorie intake rising (from 2266 Kcal in 1991-92, to 2318 Kcal in 2010), as well as increases in the consumption of protein (from 62.72 g in 1991-92 to 66 g in 2010). The long-term solution to this problem is a food-based approach. Therefore, a food-based initiative to improving nutrition for household food security in Bangladesh should be undertaken with a long-term goal for sustainable improvement of food and nutrition of the rural poor. Fish and aquatic animals are much healthier source of protein compared to livestock commonly consumed by human (FAO, 1997). However, the production of fishes is not in harmony with the population growth. Polyculture is now the most common practice of carp culture and several species combinations and stocking rate have been developed. The greater Noakhali is situated in the central coastal zone of Bangladesh along the northeastern coast of the Bay of Bengal. Therefore, aquaculture practices in the new settlement area like the news chars are complex. Therefore, a food-based initiative to improving nutrition for household food security in Bangladesh have undertaken by the BLRI component of the sub project with a long-term goal for sustainable improvement of food and nutrition of the rural poor. The eastern hill district Khagrachari is comparatively less developed area due to natural position and agro-ecosystem, low level of management in agriculture, migratory nature of people and distance form headquarters of development agents.

Progress:

BLRI component: had objectives of improving household agro-processing, preservation, value addition and marketing optimizing income and ensuring awareness building on nutrition, environment conservation and gender issues among the poor. In the last 24 months, the sub-project introduced a number of crops with new varieties in the project location which increased the yield and production of the selected farm household. The production of some different types of lean season fruits like malta, ber, wood apple, kotbell, ata, lotkon,

sofeda, amra, shorifa, etc. are yet to come. Different agricultural technologies like, alok phad, mulching, drip irrigation were maidenly handled by farmers. A training on honey bee culture was conducted and distributed box amongst the interested farmers. Almost all the farmers were started making compost by household wastage with livestock manure to avoid excessive use of fertilizers. The dietary and nutritional assessment of the selected household was assessed in terms of calorie intake and BMI value. Moreover, livestock and fisheries activities were also performed among the farmers to ensure food security as well as increase nutrition status.

Nutritional study in 2 villages with 282 participants (40% male, 41% female and 19% children) showed 24% population are with normal BMI while 21% were underweight. The table below detailed out the results.



Red lady papaya production at the hills

Table 3.6: Evaluation on BMI by gender (Monigram site)

BMI Category	Monigram site			Punchmile site		
	Men % n	Women % n	Total % n	Men n (%)	Women % n	Total % n
Underweight	18 (32.14)	26 (45.61)	22 (38.87)	28(48.28)	24 (40.67)	26 (44.98)
Normal	25 (44.64)	19 (33.33)	22 (32.98)	16 (27.71)	22 (37.28)	19 (32.5)
Overweight	11 (19.29)	6 (10.52)	8.5 (14.91)	10 17.5	8 (14.03)	9 (15.78)
Obese	2 (3.57)	6 (10.52)	4 (7.04)	4 (7.14)	5 (8.47)	4.5 (7.8)

**p*-values for comparisons between genders by chi-square tests.

BMI category: underweight, BMI < 18.5 kg/m²; normal, 18.5–22.9 kg/m²; overweight, 23–27.5 kg/m²; obese, >27.5 kg/m²

NSTU component: The component aimed to develop an eco-friendly modified carp culture system for homestead ponds for increasing family nutrition intake and income generation in the central coastal region of Bangladesh, this study is continuing investigation on biological productivity of homestead ponds, nutritional and health status of coastal communities, socioeconomic condition of coastal communities, fish diversity with their nutritional value. In the reporting year, study on measuring biological productivity, phytoplankton and zooplankton were major thrust. A total of 34 phytoplankton genera of five classes were identified as Cyanophyceae (5 genera, 13%); Bacillariophyceae (4 genera, 5%); Dinophyceae (3 genera, 10%); Euglenophyceae (4 genera, 41.5%) and Chlorophyceae (18 genera, 30.5%) during study period in the homestead ponds of Noakhali. The mean abundance of phytoplankton was $186.13 \pm 129.34 \times 10^4$ cells L⁻¹ in monsoon and $144.40 \pm 107.26 \times 10^4$ cells L⁻¹ in winter. A total of 15 genera of zooplankton was observed during the study which includes Rotifera (8 genera, 53%); Copepoda (3 genera, 20%); Crustacea (4 genera, 27%). The maximum density of zooplankton was 294×10^3 and minimum 11×10^3 ind\L with an average density 77.8×10^3 ind\L.

To understand the nutritional and health status of the beneficiaries, the BMI and hemoglobin level were measured. According to BMI, maximum (40%) of the fish farmers belonged to normal nutritional status and minimum (10%) were in Chronic Energy Deficiency (CED₂), overweight and pre-obese. About 40% of homestead pond fish farmers were found in non-anemic (≥ 130 g/l)



Marketing of the product from the spot

and 60% were found prevalence of mild anemia (110-130 g/l) based on hemoglobin level. To know the nutritional value of homestead pond fishes, nutrient composition were determined. The mean composition of moisture was 75.13 ± 3.06 %, protein was 14.65 ± 1.47 %, lipid was 2.60 ± 0.93 %, fibre was 1.19 ± 0.28 %, ash was 3.94 ± 1.42 % and carbohydrate was 2.74 ± 1.48 %.

For developing an eco-friendly modified carp (Catla, Gibelion catla; Rui, Labeo rohita; Mrigal, Cirrhinus mrigala and Kalibaus, Labeo calbasu) polyculture, an experimental site was selected including 9 ponds with three treatments. The weight gain (g) were 276.84 ± 106.24 , 472.33 ± 233.16 , 818.13 ± 275.13 in the T1, T2, T3 respectively. The specific growth rate (% bw/d) were 0.50 ± 0.04 , 0.66 ± 0.12 , 0.91 ± 0.07 in the T1, T2, T3 respectively. The survival rate (%) were 83.80 ± 0.93 , 86.72 ± 3.57 , 88.34 ± 4.09 in the T1, T2, T3 respectively. Net yield of T1 was 1.13% higher than treatment T2, and 1.1% than treatment T3. Findings clearly indicated that carp polyculture with seeds about 150-250 g at stocking density of 370 kg/ha performed better in terms of growth, yield and economics.

7. Project Title: Development of lean season fruit varieties and management packages (ID-013)

Coordinator	: Chief Scientific Officer, Pomology Division, HRC BARI, Gazipur-1701
Implementing organization	: Pomology, Pathology and Entomology Divisions of BARI
General objectives	: Development of lean season, high yielding and good quality fruit varieties and management technologies including insects and diseases to Improve income and livelihood of the people

Duration : Jun2018 to May 2021

Budget : Tk 20000000/-

Background: Except banana and papaya, most of the fruit species in the country are seasonal. As a result, more than 60% fruits are available during mid-May to mid-August and less than 40% during the rest eight months. Bangladesh has an immense diversity of 70 various fruit species. People get adequate quantities of fruits during the four summer months. In other months, there is an acute shortage of native fruits. At that time, Bangladesh imports a huge quantity of fruits at a cost of hard-earned foreign currency. The present annual production of fruit is about 45.80 lakh metric tons from an area of 1.40 lakh hectares (BBS, 2016), which is far behind of total requirement. The present availability of fruits is only 79 g/person against the requirement of 200 g. Fruits provide adequate quantity of vitamins, minerals, phytochemicals, organic acids, enzymes etc. Without nutritional security, food security can never be achieved. As a result of accomplishing intensive research through the proposed project, lean season fruit varieties as well as improved management packages are planned to be developed, to ensure availability of fruits in the lean period of the year with a view to mitigate the nutritional requirements and give additional income to the people. The project is being implemented by Pomology Division, Horticulture Research Centre, BARI, Gazipur; Breeder Seed Production Centre, Debiganj, Panchagarh; Hill Agriculture Research Station, Raikhali, Rangamati and Regional Agricultural Research Station, Rahmatpur, Barishal.

Progress:

BARI (Pomology Division) component: Collection, characterization and evaluation of the promising lean season germplasm are being performed at all the project locations. By this time 7 germplasm of fig (Teen), 8 of bullock's heart, 12 of custard apple, 3 of ber, 2 each of bael and wood apple have been collected and planted in the Fruit Research Farm. At Hill Agriculture Research Station, Raikhali, Rangamati; 3 germplasm of bullock's heart, 2 of pear and 1 each of ber, pummelo, pear, strawberry, avocado and mango collected and planted in the research field. At Breeder Seed Production Centre, Debiganj, Panchagarh; 2 germplasm each of sapota, pummelo and jaboticaba and one each of barmese grape, ber, phalsa and river ebony collected from

the northern part of Bangladesh. At Regional Agricultural Research Station, Rahmatpur, Barishal; 5 germplasm of bael, 6 of pomegranate, 5 of custard apple, 5 of bullock's heart, 4 of river ebony, 2 of olive and 5 germplasm of jamun have been collected and planted in the research field. Evaluation and characterization of the existing and collected germplasm are being continued. At HARS, Raikhali; among 4 bael germplasm one (1) was found promising. At DEB, Debiganj; 2 germplasm of bullock's heart, 5 of bael, 16 of carambola, 6 of elephant's foot apple and 3 germplasm of peach were evaluated and characterized and both of the 2 germplasm of bullock's heart, 2 of bael, 2 of carambola, 1 of elephant's foot apple and 2 germplasm of peach fruit were found promising.



Wood apple germplasm

Two fertilizer studies on golden apple (2nd year) and one fertilizer experiment on Malta (1st year) are being completed at the Fruit Farm, Gazipur and RARS, Rahmatpur, Barishal. A study on propagation standardization at the DEB, Debiganj, has been set on bullocks heart and wood apple and the data collection is being continued. Propagation techniques i.e., grafting, budding, layering and cutting were used as treatments. The fertilizer study with three various doses (F1: 100%; F2: 150% and F3: 200% of the dose per plant mentioned in the FRG, 2018) and four different application methods where fertilizer was applied I0: once (September-October), I1: twice (September and April), I2: thrice (September, March-April and May-June) and I3: four times (September, November, March-April and May-June); was conducted during September 2018 to June 2020 with BARI Golden apple-1 and BARI Golden apple-2. Fruits were harvested in September 2019 in the first year but harvesting of 2nd year crop is not done yet. In BARI Golden Apple-1, in the first year, the highest number of panicles per plant (10.00) and fruits per panicle (11.53) were counted in plants received 200% of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied twice. The highest yield (0.95 kg per plant) was noticed in plants treated with 150 % of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied for three times. Again, in the 2nd year, the highest number of panicles per plant (11.00), fruits set per panicle (11.33) were counted in plants received 200% of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied twice. Again, in BARI Golden Apple-2, maximum number of panicles per plant (39.67) and fruits retained per panicle (5.45) were counted in plants received 200% of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied thrice (F3I2) and twice (F3I1), respectively. In another experiment with BARI Malta-1, the highest number of fruit set per plant (74.33) and fruits retained per plant (63.00) were counted in plants treated with 100 % of the recommended dose plus 30 kg vermicompost.

A survey and identification of major diseases and insect-pests of lean season fruit crops were conducted in Barisal, Panchagarh and Gazipur regions under Component-II and Component-III, respectively. Experiment on screening of the chemicals fungicides against fruit dropping of lotkon was set at Joydebpur, Gazipur and the other experiment on development of bio-rational based integrated disease management packages against major diseases of lean season fruits has been set at all project locations under Component-II. Gummosis disease of golden apple and wood apple were found as the major problems in all the regions. Fruit dropping and die back of sapota, burmese grape (*Baccaurea sapida*) and gray leaf blight caused by *Pestalotiopsis* sp. were observed as minor diseases.

Under Component-III, hog-plum beetle and trunk borer of hog-plum tree were noted as major insects in Barisal region. Research experiments on



development of environment friendly management approach against fruit borer of Burmese grape (lotkon) and development of management approach against hog-plum beetle, podontia 14-punctata are being conducted at Joydebpur, Gazipur under Component-III.

8. Project Title: Integration of postharvest technologies and best practices in the value chains of fruits and vegetables (ID-016)

Coordinator	:	CSO, Post-harvest Technology Division, BARI, Joydebpur, Gazipur.
Implementing organization	:	PHTD, FMPED, PHTS of BARI & DU
General objective	:	To improve the quality and safety of fruits and vegetables by introducing new tools, machinery and means of harvesting, handling, packaging and cool chamber facilities to reduce post-harvest losses
Duration	:	Jun 2018–Jun 2021
Budget	:	Tk: 18477763/-

Background: Postharvest quality and produce safety are considered very important and prioritized by the government of Bangladesh. The country has enormous potentials of fruits and vegetables for domestic and foreign investments if critical requirements are maintained in the entire supply chain. Proper postharvest handling practices are important to reduce postharvest losses and improve overall harvest quality of fruits and vegetables. For the purpose, existing technologies should be improved and new technologies to be intervened. Growing populations of the country continue to create demand for fresh produce and processed horticultural products. Meeting these requirements as well as those of export markets necessitates assuring quality and safety in both domestic and export supply chains. Capacities must therefore be developed in order to respond to consumer and market demands. The integration of improved technologies such as use of simple postharvest tools and equipment, use of plastic crate or innovative packaging system along with the use of sanitizer and best practices would be able to reduce the postharvest losses to minimum. Mango is very much popular, nutritionally rich, commercially cultivated high value fruit. Bananas are available round the year and have the highest per capita consumption (BBS, 2014). Brinjal, cauliflower and carrot are high value vegetables and have significant role in agribusiness sector in Bangladesh. High postharvest losses of these crops are reported in the supply chain of country (BARI Annual report, 2008-2013). The present project is designed on up-scaling and validation of potential postharvest technologies of the mentioned crops. Thus, this proposed project ultimately aims in integrating improved tools for harvesting, handling, packaging and storage operations, cleaning and sanitization practices, and building capacity of stakeholders who directly involved in the value chain of selected crops.

Progress: Two pack houses including two cool bot cold storage were established at the adjacent area of assembles market of selected fruits and vegetables. One was at Baneswar Bazar, Rajshahi for mango and other fruits and another was at Vatra, nearby Mirzapur Bazar, Sherpur Upazilla, Bogra. The latter was targeted for vegetables and banana (brinjal, cauliflower and carrot). To intervene of improved technologies and best practices in value chain, four studies were conducted on mango, banana, carrot and cauliflower. Best practices of integration of postharvest technologies on mango, banana, carrot and cauliflowers were identified. It helps in maintenance of quality and reducing postharvest losses of target crops in the value chains.

BARI component: Washed (sanitizer—CCA and NaOCl) and unwashed carrots were packed in jute sack, plastic crate, CFB carton with polyethylene lining stored in commercial cold storage of ASKEO MSP Centre Limited, Ashulia during 2019 and Ganda cold storage, Saver, Dhaka during 2020. Washed carrot showed more brightness and more yellow packed in CFB carton and plastic crate with polyethylene sheet having 0.05 mm thickness compared to unwashed packed in jute sack. In case of h°, washed carrot by sanitizer was found highly significant followed by unwashed carrot at significant level of 5%. CCA washed carrots showed better

performance in respect of colour and microbial load than NaOCl washed carrots. On the other hand, the best package was observed in NaOCl washed carrot packed in plastic crate but NaOCl is Cl rich component that is harmful for human health. So, CCA washed carrot packed in plastic crate or CFB carton is suitable for local market or supper and export market. Mature washed carrot with sanitizer is stored in commercial cold store for 5-6 months at 0.1-4.30°C and 76 -94% rh. Cleaning efficiency and washing efficiency should be maintained at 96% and 98% respectively. At this condition, storage life would be extended by two months and reduced postharvest loss by 10% compare to traditional practice. Washed carrots no need further washed with water after delivering from the cold storage but unwashed carrots needed washed with water essential for cleaning mud from the surface of carrots. The aerobic bacterial count (APC) count and total coliform count (TCC) were recorded as 5.6 log CFU/g and 3.8 log CFU/g, in unwashed carrot samples in 0 month of storage during March 2019. Yeast and mold count was recorded as 4.7 CFU/g at 0-month storage. Higher reduction of APC, and TCC counts was observed with CCA washed carrot compared to NaOCl washed carrot. Similar reduction of yeast and mold counts were observed in CCA or NaOCl washed carrot. The CCA washed carrot showed higher total phenolic content than that of NaOCl washed carrots. Irrespective of washing materials the total phenolic content reduces. In all the chemical parameter analyzed, non-washed carrot showed higher values compared with washed carrots. The bruising carrot by the washing machine was one percent.



Washing carrot by BARI root crop washing machine in Mar2020

BARI Aam-3 was collected from Rajshahi those were treated with different treating temperature (50, 55 and 57 °C) and exposure time (3, 5, 7 and 9 minutes) during 26 June 2019 at FMPE Division, BARI, Gazipur. The treatment combinations increased the shelf-life of the variety of BARI Aam-3 by 33% compare to untreated fruits. Disease severity of treated mango was reduced by 79% over untreated fruits. The higher firmness (7.75-9.32N) was found in treatments of T1t4 (50°C for 9 min), T2t2 (55°C for 5 min), and T2t4 (55°C for 9 min) compared tountreated mango (6.47N). These treatments showed good rigidity of mango. The best treatment combination of BARI Aam-3 is 55°C for 5 minutes. The variety of Rangin sagar banana cultivated new sucker in own land at Shibpur, Chargat, Rajshahi district. The maturity parameters of banana such as firmness (74.46-81.35 N), °Brix (3.4), angularity (45.75-52.67°), colour parameters (L*,h°,C* as 47.12-52.82,117.12-119.99, 27.88 respectively) were recorded. Temperature inside the crate and bunches increased with the traveling period whereas rationally relative humidity decreased. Speed of ripening process of banana was accelerated for increasing temperature during the traveling period. Bruising losses included surface rupture, injury, crack and damage and 80 percent surface rupture loss (47%), 20 percent injury, crack and damage losses (12%) out of 59% losses. The hue angle of banana varied from 117-120 at harvest and 116-124 at unloading. It indicated that the peel colour of banana was deeply green. There was no significant difference among the treatments in respect hue angle, chroma and brightness. Two protocols of supply chain for banana transportation from



After unloading, compare between without wrapping (top) and wrapping with news paper in the CFB carton

orchard to Banessar assemble market to Binadpur, Rajshahi to Gazipur wholesale market; and directly orchard, Shibpur, Rajshahi to Gazipur wholesale market were developed. The up/down speed of the lifter was found to be 0.04 m/s and 0.24 m/s during without load whereas speeds decreased about half of the unloading speed when load is applied on the platform of the lifter from 65 kg (self-weight of one man) to 195 kg (self-weight of three men).

DU component: CCA washed carrots showed better performance in respect of colour and microbial load than NaOCl washed carrots. The aerobic bacterial count (APC) count and total coliform count (TCC) were recorded as 5.6 log CFU/g and 3.8 log C.F11/g. in unwashed carrot samples in 0 month of respect of colour and microbial I count and total coliform count ed carrot samples in 0 month of s 4.7 CFU/g at 0-month storage. 3shed carrot compared to NaOCl (served in CCA or NaOCl washed ent than that of NaOCl washed tent reduces. The non-washed id *S. aureus*, but no pathogenic spp, vibrio cholera and yeast & none of the pathogenic bacteria udied. Bagging has been widely nance in respect of colour and microbial nt (APC) count and total coliform count unwashed carrot samples in 0 month of orded as 4.7 CFU/g at 0-month storage. 1CCA washed carrot compared to NaOCl were observed in CCA or NaOCl washed)lic content than that of NaOCl washed olic content reduces. The non-washed , TCC and *S. aureus*, but no pathogenic ihigella spp, vibrio cholera and yeast & ddition, none of the pathogenic bacteria 0 Kg) studied. Bagging has been widely of spoilage. Although bagging was able ?rial, yeast & mold contamination on the ; able to kill yeast & mold and reduce ve of treatment combination, hot water an that of other combination treatment loth bagging and non-nagging mangoes n terms of microbial quality DU Component: CCA washed carrots showed better performance it load than NaOCl washed carrots. The aerobic bacterial count (APC (TCC) were recorded as 5.6 log CFU/g and 3.8 log CFU/g, in unwash storage during March 2019. Yeast and mold count was recorded a Higher reduction of APC, and TCC counts was observed with CCA washed carrot. Similar reduction of yeast and mold counts were of carrot. The CCA washed carrot showed higher total phenolic cont carrots. Irrespective of washing materials the total phenolic cor control mango sample containing higher presence of TABC, TCC al bacteria including *E. coli*, *Bacillus cereus*, *Salmonella* spp, *Shigella* mold including *A. niger*, was recorded in control sample. In addition, and yeast & mold was recorded in the mango samples (900 Kg) st DU Component: CCA washed carrots showed better perforr load than NaOCl washed carrots. The aerobic bacterial cou (TCC) were recorded as 5.6 log CFU/g and 3.8 log CFU/g, in storage during March 2019. Yeast and mold count was rec Higher reduction of APC, and TCC counts was observed witi-washed carrot. Similar reduction of yeast and mold counts carrot. The CCA washed carrot showed higher total phenc carrots. Irrespective of washing materials the total phen control mango sample containing higher presence of TABC bacteria including *E. coli*, *Bacillus cereus*, *Salmonella* spp, mold including *A. niger*, was recorded in control sample. In a and yeast & mold was recorded in the mango samples (9C practiced in mango orchard to inhibit fruit fly, major causes to inhibit fruit-fly successfully but unable to reduce the bact(fruit surfaces. Hot water treatment at 50°C for 5 min wa: resident bacterial populations to 1.0-1.5 log cfu/g. Irrespecti + sanitizer treatment showed better microbial reduction th. studied. Furthermore, hot water + sanitizer treatment of t followed by transportation in refrigerated van showed best in terms of microbial quality.

9. Project Title: Development of production package for export and processing potatoes to sustain productivity and food security in Bangladesh (020)

Coordinator	:	Director, Tuber Crops Research Centre (TCRC), BARI, Joydebpur, Gazipur
Implementing organization	:	BARI, Joydebpur, Gazipur; SAU, Dhaka; Giant Agro Gold Storage, Dhaka and Kashem Food Products, Gazipur
General objective	:	Development of processing and export quality potato through in-country hybridization and exotic variety selection in suitable locations with minimum cost
Duration	:	Nov 2018 – Jun 2021
Budget	:	Tk: 3,39,83,990/-

Background: Exporting of fresh potato is in nascent stage for Bangladesh. Many neighboring and Middle Eastern countries need fresh potatoes for table consumption. There is also possibility of exporting potatoes to Russia and European countries; because their harvesting time is quite different from Bangladesh. Potato processing has come up with a little progress in last 15 years. More than 15 processing industries have been established, but most of those are out of operation due to shortage of quality raw materials. The produced potato in Bangladesh is not as good as that of the temperate countries. For economic processing and export, the fresh potato tubers should be of larger size, high in dry matter content, low in reducing sugar, good in crispiness and better in keeping qualities. As the duration of crop production period is short in BD, the tuber size is small and dry matter production is relatively low. As such, it is not well-accepted for export and processing. So, it is very much essential to develop varieties locally with high dry matter and low reducing sugar through positive selection. For immediate solution, available exotic varieties must be tested for suitability of the varieties for export and processing. Similarly, crop production techniques such as planting time, seed size, plant population, fertilizer dose, water application, etc. should be standardized to meet up with the required qualities of the processing tubers. In addition, the use of CIPC for storing potatoes at relatively higher temperatures can reduce storage cost as well as suppression of sprouts, but that has to be standardized through experimentation. The project has been designed with a complete set of activities for present and future, which include variety development under Bangladesh condition, variety introduction from outside for selection, and testing of existing varieties for immediate use, agronomical studies for accelerated production of dry matter, enzymatic and biochemical analysis of the processed products at SAU (including a Ph.D. research fellowship for in-depth studies), cost reduction studies at Giant Agro cold storage in Thakurgaon, and commercial viability study at Quasem Food Products Ltd. in Gazipur.

Progress: The sub-project has been designed with a set of activities to develop new varieties and improved agro-techniques relating to potato production suitable for export and processing. The activities included 1) variety introduction and selection for use in near future, 2) development of breeding lines and varieties through hybridization suitable for long term use in future under Bangladesh condition, 3) testing of existing varieties and advanced lines for immediate use, 4) agronomical studies for accelerated production of dry matter, 5) enzymatic and biochemical analysis for testing the quality of the products, and 6) the use of chemicals and storage techniques in order to steady supply and reduce the cost of the products.

In order to achieve these objectives TCRC has taken the lead activities through the use of BARI facilities, Sher-E-Bangla Agricultural University (SAU) has been conducting some basic studies through graduate students (some agro-techniques and biochemical studies), Giant Agro Processing Ltd. has been using their cold storage facilities in Thakurgaon for cost reduction and storage studies, and Quasem Food Products Ltd. are doing the commercial viability and export quality studies at Gazipur. All these studies have been designed to complete within three years' time.

All the experiments were set up in time by TCRC, BARI. However, in some places there were little variation in setting time due to climatic problems. In total 92 experiments were set up at 11 different locations throughout the country. Up to now, all the experiments are in good condition. Some of those have already been harvested and data are being processed for reporting. Almost all the field experiments were completed in time. Results were also found encouraging, although some experiments were partially damaged due to heavy rain



after planting, especially at Munshigonj. Post-harvest experiments were also set up in time, but some of those could not be completed in time due to COVID pandemic e.g. CIPC experiments. Among the major achievements, 255 grams of hybrid TPS in 914 combinations and 400 kg hybrid seedling tubers in 160 combinations were obtained as well as identified more than 40 varieties and advanced lines were identified which showed promising results for export and processing quality potato production.

SAU has conducted some agronomical studies for accelerated production of dry matter, enzymatic and biochemical analysis of the processed products through PhD students along with the TCRC scientists.

Giant Agro has produced few tons of potatoes in their field. They have already stored and set an experiment in their cold storage at Thakurgaon with the CIPC in order to reduce the cost of the processed products. Quasem Food Products Ltd. in Gazipur has been doing some processing activities as well as time to time check the qualities of the products of different varieties.



Experimental Field View at SAU, Dhaka



Potato Storage with CIPC by Giant Agro



Processed Products of Potato by Quasem Food

10. Project Title: Cost and return analysis of selected crops in Bangladesh (ID-021)

Coordinator	: Member Director (AERS), BARC, Farm gate Dhaka - 1215
Implementing organization	: BARI, BINA
General objective	: To generate a complete socioeconomic database on major agricultural crops (except rice & sugarcane) cultivation practices at farm level

Duration : Jan 2018 – Jun 2021

Budget : Tk: 23199597/-

Background: Reliable data on costs and returns of crop production are needed to understand the underlying processes that influence the output and productivity of crop sector, and how these are impacted by new policies and regulations. Cost-return data can serve as a means of understanding and assessing farm operations. It allows producers to question their own operations and to benchmark it against the best practices of farms in the same region with similar physical characteristics. This in turn can lead to better farm-level decisions and improved market efficiency and performance. Resource scarcity has led the production economists to think about the reallocation of existing resources to have more output with given level of input combinations or to produce a prescribed level of output with the minimum cost without changing the production technology. But there is a lack of information about the efficient use of inputs in crops production. Similarly, measurement of productive efficiency in agricultural production is an important issue, because it gives pertinent information for making sound management decision in resource allocation. Except for a few descriptive studies, econometric analysis has yet to be conducted to examine the production function for crops cultivation and its potential for future improvement. To formulate appropriate planning for the sustainable development of agriculture sector, reliable data on crop production are urgently needed. The proposed study will generate socioeconomic database on crop production which can be used by policy

makers and extension personnel to fill up the knowledge gap in this sector. The sub-project is coordinated by AERS Division of BARC with two implementing partners: i. BARI Component and ii. BINA Component.

Progress: The study is an attempt to determine the level of input use and estimate the cost and return of selected crops, to estimate the level and determinants of farm-level technical efficiency of farmers cultivating selected crops and to identify constraints and opportunities related to crop cultivation at farm level. A total of 25 types of crops including cereals, pulses, oilseeds, tuber crops, vegetables, spices, fruits and fibre crops were considered in the sub-project. For data collection, a total of 11,700 farm households were selected, out of which 6,750 were allocated in the first year and the rest 4,950 for the second year of the sub-project period. Out of 11,700, BARI Component covered 9,450 sample respondents from 21 selected crops. The BINA Component dealt with collection of required data from 1,350 sample respondents from 3 oil seed crops. In addition to coordination, BARC Component will gather required data from 900 sample respondents from Jute crop. In each selected location (district), 3 upazilas were selected based on area coverage of the respective crop for conduct of the survey.

During the first year of the sub-project period BARC, BARI and BINA completed site (district) and farmers selection, questionnaire preparation and pre-testing, manpower recruitment and related activities in compliance of the sub-project proposal. Scheduled field visits and monitoring by BARC were started immediately after the sub-project initiation in other implementing organizations (BARI and BINA Components) in order to identify problems and to find out effective measure. Required actions were taken by all participating organizations (BARC, BARI and BINA) under the sub-project to carry out field surveys. Under BARC component, data collection for 900 samples (Tossa Jute: 675 and Deshi Jute: 225 samples) were completed in selected study areas. Focus Group Discussion (FGD) in selected areas was completed by BARC. Similarly, data collection (1350 samples) under BINA component for 3 oilseed crops (mustard, groundnut and sesame) was also completed and FGD is in progress. Data collection and FGD under BARI component were nearly completed. At present data editing, coding and computer entry for analysis are in progress as per schedule stated in the sub-project proposal. All these activities are being conducted simultaneously in the current year and to be continued afterwards. After completion of data analysis, detailed result/information will be published/incorporated in the forthcoming reports in 2020-21. This report presents different partial results (input use and costs structure, financial and economic profitability) based on information collected so far from a variety of crops studied under 3 components (BARC, BARI and BINA) of the project.



Production of lentil in the farmers' field

11. Project Title: Development of integrated crop management technologies for higher production of coconut in Bangladesh (ID-026)

- Coordinator** : Dr. Debasish Sarker, CSO & Head, Entomology Division, BARI, Joydebpur, Gazipur
- Implementing organization** : Entomology, Pomology and Pathology Divisions of BARI, SSURDA
- General objective** : Development of integrated crop management packages on production and protection aspects of coconut through on-farm validation and up-scaling of ICM packages

Duration : Jun 2018–Dec 2020
Budget : Tk: 1,30,00000/-

Background: In Bangladesh, coconut is considered as a crop of high economic value for its diversified uses. However, the yield is about 21 nuts per tree per year, which is very low, compared to other coconut-growing countries. Among the coconut growing countries of the world, Bangladesh ranked 19 in case of areas, while production status ranked 30 and yield 77 (FAOSTAT 2012). So, it is clear that there is enough space to increase production and yield of coconut in Bangladesh. This poor yield is due to lack of high-yielding varieties, inadequate nourishment with lack of pests and diseases management. Recently coconut farmers are seriously suffered by coconut eriophyid mite, along with other insect pests, viz. red palm weevil and rhinoceros beetle. Bud rot, grey leaf spot etc. are prevailing major disease problem, while root wilt and leaf rot diseases may be the serious threats for its future production. Unfortunately in spite of the importance of coconut in the national economy, due importance has not been paid for the improvement of this crop. Recently steps has been taken to import high yielding varieties from different countries like Vietnam and India but very few works has so far been done on integrated nutrient, water and pest management.

Progress: Entomology Division, BARI coordinated the project and set 03 experiments in current cropping year to improve the management of eriophyid mite and rugose spiraling whitefly. The experiments are: i) Bio-rational based management of Coconut Eriophyid Mite; ii) First record of the invasive rugose spiraling whitefly infesting coconut in Bangladesh and iii) Management of Rugose Spiraling Whitefly infesting Coconut. The results of bio-rational management of mites showed that management package comprising of Sanitation + four sprays of chemical miticide Chlorphenapyr 10SC (Intrepid) @ 1.0 ml/liter of water offered highest reduction (86.66%) of mite infestation over control which was followed by Sanitation + four sprays of Abamectin 1.8 EC (Vertimec) at 1.2 ml/liter of water. Performance of *Beauveria bassiana* and Azadirachtin 1% was not satisfactory. The highest nut infestation (77.87%) was recorded in control trees.



On-going field experiment at BARI, Gazipur on management package of coconut eriophyid mite

Table 3.7: Effect of various treatments on mite infestation in coconut during 2019-20 at BARI, Gazipur

Treatments	Mean infested nut (%)	Infestation reduction over control (%)
Sanitation + <i>Beauveria bassiana</i>	48.53c	37.67
Sanitation + Azadirachtin 1%	52.18b	32.99
Sanitation + Abamectin 1.8 EC	16.34d	79.02
Sanitation + Chlorphenapyr 10SC	10.39e	86.66
Untreated control	77.87a	-
C.V. (%)	7.42	-

Rugose spiraling whitefly infestation effectively reduced by Tundra 50 SP (73.79%), followed by Admire 200 SL (69.85%) and Bio-clean (60.00%). Following table illustrated the results.

Table 3.8: Effect of different treatments on the population reduction of RSW adults during December 2019 to February 2020 at RARS, Jashore

Treatments	Mean RSW adult population/ leaflet		% Reduction of RSW adult over pre-treated at 7 DAS
	1 DBS	7 DAS	
Pegasus 500 SC	26.80	13.67b	48.99
Fytoclean	27.00	16.00 b	40.74
Bioclean	26.67	10.67c	60.00
Tundra 50 SP	27.20	7.13d	73.79
Admire 200 SL	26.53	8.13cd	69.85
Untreated control(water spray only)	26.87	25.66a	4.50
CV%	4.93	11.65	-

The pomology division sets 03 experiments on fertilizer, irrigation and growth regulators to observe the effect on growth and yield of coconut. While the pathology division sets one experimnt (Management of grey leaf spot and bud rot disease of coconut,) to manage leaf spot and bud rot of coconut.

Table 3.9: Effect of different treatments to control grey leaf spot and bud rot disease of coconut

Treatments	Incidence (%)	Severity
T ₁ = Sanitation at July and December	77.77	1.55
T ₂ = Application of biocontrol agents @200g/plant	100	2.22
T ₃ = Application of nutrients	100	2.55
T ₄ = Application of phenolic compounds	88.88	1.66
T ₅ = Chemical fungicides (Autostin and Secure)	44.44	0.44
T ₆ = No treatment (farmers practices)	100	4.44

The SSURDA component did the Field validation of ICM technologies of coconut in the farmers' fieldat Bagharpara, Jashore. Around sixty coconut trees belonging to 10 farmers were brought under validation trial.

*Field validation trial at Bagharpara, Jashore*

12. Project Title: Up-scaling of mud Crab (*Scylla olivacea*) aquaculture in Bangladesh: adoption of innovative techniques from seed production to fattening and health management (ID-029)

- Coordinator** : Chief Scientific Officer, Shrimp Research Station, BFRI, Bagerhat-9300, Mobile: +8801712103181; Email: kkuabd@yahoo.com, kkuabd@gmail.com
- Implementing organization** : BARC, BFRI, KU
- General objective** : Development and establish a framework of mud crab aquaculture for sustainable production through conducting research on each critical stages of life cycle in accounting the pathogenic (microbial) threats on respective stages.
- Duration** : May 2018 - Apr 2021
- Budget** : Tk: 2,62,54,768/-

Background: Mud crab (*Scylla* spp), an uncommon export oriented aquaculture has been exploiting commercially in Bangladesh since early 1980's around the coastal belt (Hasanuzzaman et al., 2014). Mud crab from Bangladesh is being exported mostly in live forms and the soft shell crabs in frozen forms. In 2013-14, Bangladesh earned \$22.91 million by exporting 8,520 tons of live crabs. The demand and price of mud crab in the international market is increasing tremendously (Shelley and shelly, 2013). The noteworthy contribution of mud crab in foreign exchange earnings and providing livelihood opportunities made the sector as an industry in Bangladesh. Besides the hard shell crabs, the recent interventions of soft shell crab shedding has opened a new arena in mud crab aquaculture in Bangladesh. A few number of commercial soft shell crab shedding farms are operated in South-east and South-west coastal region. Both hard shells grow out and fattening as well as soft shell shedding practices are spreading exponentially. Despite the potential role in the national economy and livelihood improvement, mud crab aquaculture is not well established in Bangladesh except fattening. About cent percent of the crabs are being caught from natural sources thus caused intense pressure on the natural stock. However, beside aquaculture, brood stock development in captive condition and seed production in hatchery level and diagnosis of diseases are the bottleneck in mud crab sector. Thus, a collaborative research sub-project was developed and implementing jointly by Brackishwater Station of Bangladesh Fisheries Research Institute (BFRI), Paikgacha, Khulna; and Fisheries and Marine Resource Technology (FMRT) Discipline, Khulna University. BFRI conducting research on brood stock development, seed production and various aspects of culture and fattening of mud crab. Khulna University is dealing with bacterial infection/diseases in mud crabs in natural stocks and also in each respective trial conducted by BFRI.



Crablet produced from different water treatment protocol

Progress: Brackishwater station of BFRI conducted the 1st experiment for brood stock development simultaneously in earthen ponds, cemented tanks and plastic drums. Brood stocks were collected from three different locations (Khulna, Satkhira and Bagerhat) and reared for berried brood production. Highest spawning success and production of viable zoea was observed for brood stock collected from Khulna region than other two places. Findings of this trial suggested collecting the brood stock from nearby locations to reduce stresses. The 2nd experiment was carried out on larvae rearing with different water treatment plans, viz, water treated with pre-biotics and probiotics (T1); with prophiolaxis (T2); and with prebiotic, probiotics and prophiolaxis (T3). Higher larval stage index (LSI), faster metamorphosis in each stage and significantly higher survival of 7% at crablet stage was achieved from T3 (with prebiotic, probiotics and prophiolaxis) than

other two treatments. Result of this experiment suggested using prebiotic, probiotics and prophylaxis to enhance the survival with minimizing disease incidence in mud crab larvae rearing. The 3rd and 4th experiments were conducted on nursery of mud crab with different habitats and different stocking densities, respectively. Nursery trials suggested that sufficient shelters and sediment touch provide better survival. It also suggested that lower stocking provided better survival and intactness.

Regarding the disease incidence, Khulna University is dealing with bacterial infection/diseases in mud crabs in natural stocks and also in each respective trials conducted by BFRI. The primary data from field visits, and secondary data from books, journals, report etc. are being collected. Crab samples, healthy and unhealthy, were collected from fattening farms. Some samples which were apparently infected were collected from wild. The microbial analysis shows that the total bacterial load and *Vibrio* spp. load were comparatively higher in infected mud crabs. *Aeromonas*, *Pseudomonas*, *Escherichia*, *Salmonella*, *Shigella*, *Enterococcus* and *Klebsiella*, *Enterobacter* were isolated from wild mud crabs as well as in farmed mud crabs. Higher *Vibrio* spp. load was found in mud crab samples from farms of Khulna districts. However, all these activities are continued and will be repeated in the next year for improvement and fine tuning. Additional experiments will also be conducted as proposed in the sub-project.

During the reporting period, the BFRI coordination component arranged coordination meeting both physically and virtually with the PI's and Co-PI's at each research site of the sub-projects to link up their activities with one another. Routine in situ supervision of each research component will follow as per work plan.

13. Project Title: Investigation and characterization of viral and bacterial diseases in highly consumed fin fishes and shrimp in Bangladesh and development of their vaccines and validation (ID-030)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka

Implementing organization : BFRI, BAU

General objective : To control and reduce mass mortality of fin and shell fish due to bacterial and viral diseases and characterization of the causative agents through biological and molecular methods to establish better health management practices in fin and shell fish aquaculture with increased productivity.

Duration : Dec 2017 - Jun 2021

Budget : Tk: 2,78,74,504/-

Background: Aquaculture in Bangladesh is growing rapidly with respect to both quantity and variety of fish species. From 2000 and 2016, aquaculture production increased from 712,640 and 2,060,408 metric tons which is much larger quantity than wild capture production (1.023 million tons) in 2015 (DoF, 2015). There are several viral, bacterial, parasitic and fungal diseases affecting total growth period (fry to adult) and their productivity in pond culture system. Though, most of the infectious diseases (parasitic and fungal) can be controlled easily but catastrophic viral and bacterial diseases which have not been detected or characterized and their control/preventive measures (through vaccination) are not available yet in Bangladesh. Freshwater fin fishes especially cat fishes, Tilapia and perch (Koi) fishes all over the world are reported to affect with the viruses of different families such as *Rabdoviridae*, *Orthomyxoviridae*, *Alloherpesviridae*, *Iridoviridae* and *Nodaviridae* (Bowser et al., 1985). Among the infectious diseases, Bangladesh has the experiences of several outbreaks of bacterial and fungal diseases in cultured Tilapia. To sustain pond culture of Gulsha (*M. vittatus*) and their productivity at the farm level there is no alternative to isolate and identify the actual aetiological agent (yet unidentified) and to develop preventive measure against the agent which is responsible for mass mortality of Gulsha in pond culture although bacteria isolation has been failed from freshly collected dead fish.

Acute hepatopancreatic necrosis disease syndrome (AHPND), formally known as Shrimp early mortality e, has recently caused serious problems in the shrimp culture industry. It occurs most frequently within the first 30 days after stocking a newly prepared shrimp pond. The aetiological agents of this disease of shrimp need to be identified and an effective preventive measure should be taken against the disease to sustain the productivity of Shrimp culture in Bangladesh. Considering the prevailing disease threats of fin and shell fish industry in Bangladesh, the principal aims of the present research has been set to know fin fish and Shrimp culture strategies and to investigate their diseases occurrence and health management problems in pond aquaculture through field observation and to isolate and characterization existing and emerging viral and bacterial agents from infected fish species and Shrimp using different cell lines (primary and continuous cell lines) and selective media. Finally, to develop highly effective vaccines with the isolated viral and bacterial agents with a view to control and eradicate the existing and emerging viral and bacterial diseases and develop specific pathogen free (SPF) fishes for future generation.

Progress: The study identified five selected high valued species of fin fishes namely Koi (*Anabas testudineus*), Tilapia (*Oreochromis niloticus*), Shing (*Heteropneustes fossilis*), Gulsha (*Mystus vittatus*) and Pangas (*Pangasius hypophthalmus*) affected with deadly bacterial and viral agents and causing high rate of their morbidity and mortality since 2018 to 2019. A new disease of V. Koi and Tilapia known as popped eye disease caused by *Streptococcus agalactiae* outbreak had been reported from cultured ponds of four different districts namely Mymensingh, Gazipur, Netrokona and Kishoreganj during April to June 2018. A total of 330 diseased fishes of which V. Koi (n=150) and Tilapia (n=180) were collected from four infected fish farms at Trishal and Bhaluka upazilla



Lesion or ulcer on body

under Mymensingh and Kaliakair upazilla under Gazipur districts in the period of December to July 2018. The bacteria (*Streptococcus agalactiae*) have been isolated and characterized by using various cultural, morphological, biochemical and molecular tests. Later on an inactivated whole cell bacterial vaccine was developed experimentally and the healthy adult V. Koi fish was vaccinated through I/M route of inoculation with different doses (0.2, 0.3, 0.4 and 0.5 ml/ fish) of the newly developed Koi fish vaccine in the aquarium at BFRI. The immunized V. Koi fishes were challenged after two weeks of booster vaccination with the virulent *Streptococcus agalactiae* isolate from the laboratory repository at a dose rate of 10^3 cfu/fish. Result of the challenge experiment in V. Koi fish indicated that the minimum dose (0.2 ml/fish) of the newly developed vaccine was able to protect (100%) fish mortality from virulent challenge until 15 days of observation.

The bacteria *Aeromonas* spp. had been isolated and characterized successfully from the dead shing fishes having ulcer on their body form different upazilas like Tarakanda, Muktagacha and Gouripur under the districts of Mymensingh during January to April 2019. The microorganism *Vibrio* spp has been isolated successfully from dead shrimp collected from different gheras of Bagerhat and Khulna districts. Detail biological and molecular characterization of the the bacteria *Aeromonas* spp. and *Vibrio* spp and the Tilapia lake virus (TiLV) isolated from Tilapia fish are under progress. After isolation of the TiLV from dead Tilapia fishes of different outbreak pathological changes in different organs like Liver, Kidney and Brain of the embryos infected with TiLV was determined by the HE staining. Severe change was noticed in the liver and kidney compared to that of brain of the TiLVirus infected embryos.

BAU component: Isolation of three important pathogenic bacteria (*Streptococcus agalactiae*, *Aeromonas hydrophila* and *Vibrio parahaemolyticus*) from five species of fishes (V. Koi, Tilapia, shing, Pangas and Shrimp)

has been completed. Isolation of deadly virus TiLV from Tilapia fish done successfully. Biological characterization of three species of bacteria was done successfully. Of the three species of isolated bacteria only one spp (*Streptococcus agalactiae*) was confirmed by biological and molecular detection (PCR). Details biological and molecular characterization of the remaining two bacterial isolates and viruses are yet to be done. Of the three isolates of bacteria from fin fishes and shrimp only one spp (*Streptococcus agalactiae*) that was isolated from V. Koi and Tilapia was used for successful development of inactivated fish vaccine. Feed based inactivated fish vaccine (for other species of fishes) with the same bacteria (*Streptococcus agalactiae*) isolated from V. Koi and Tilapia is under progress. Efficacy of the injectable form of inactivated bacterial vaccine of V. Koi was determined by challenge experiment under laboratory and field trial with the virulent isolate of bacteria (*Streptococcus agalactiae*). This vaccine was found highly effective under laboratory challenge experiment After successful completion of field trial of the first vaccine developed against *S. agalactiae* (Koi Vac.). It is targeted to develop six more types of fish vaccines of which three will be injectable and three will be feed based vaccines against two important bacterial pathogens and one viral pathogen. Research work on detail characterization of the two bacterial isolates *Aeromonus* spp. and *Vibriospp* and one virus TiLV are under progress. Trial production of vaccine based floating feed for fishes particularly V. Koi and Tilapia is also under progress.



Popped eyes disease of tilapia

14. Project Title: Development of in-situ breeding technology of prawn and adoption of sustainable eco-friendly culture of prawn and shrimp (ID 031)

- Coordinator** : Director (Research and Planning), Bangladesh Fisheries Research Institute, Mymensingh, Mobile: 01711045889, Email: nurullahbfri@yahoo.com
- Implementing organization** : BARC, BFRI, KU
- General objective** : To boost up Shrimp/Prawn production using sophisticated breeding technique and grow out management with reference to disease diagnosis & preventive measures
- Duration** : May 2018 - Apr 2021
- Budget** : Tk: 2,77,63,193/-

Background: Disease is always a problem, which harasses the healthy development of shrimp aquaculture. Both virus and bacteria can be dangerous pathogens of shrimp in aquaculture. Application of traditional antibiotics can alleviate bacteria disease, but traditional strategy used to prevent virus disease in vertebrate is not effective to cure virus disease of shrimp since no adaptive immunity exists in them. WSSV is one of the most dangerous pathogen that is highly virulent in penaeid shrimp. WSSV infection of penaeid shrimp can result in mortality of up to 90–100%.

Baseline study carried out by Khulna University showed that farmers are producing 300 to 600 kg per ha from this traditional gher farming system. However, prawn production in semi intensive system at stocking density 4-20/m² ranged from 500 to 5000 kg/ha/yr (FAO, 2016). Thus, BD has huge scope to get higher production through intensification. In addition, freshwater prawn aquaculture is threatened due to variety of factors such as misuse of antibiotics and drugs, pollution of environment, and spreading of severe diseases caused by bacterial and viral agents. Some of those bacterial and viral agents are already known; however, many of

them have not been reported yet in Bangladesh. Thus, it is now important to identify the new and unknown pathogens, and determination of virulence factors with mitigation measures. There is a national and international concern for preventing and controlling the diseases through new scientific approaches in order to make health-safe aquaculture product. Probiotics can be one of the alternatives to improve culture friendly water and soil quality, prevention of disease producing pathogen, increasing digestibility and immune competence of prawn. Thus, it is also important to isolate potential probiotics bacteria from the culture environment and go for their mass production in laboratory and pond, and attempt will also be taken to produce at industrial level.

Progress:

BFRI component: Main activities of SRS, BFRI Component were continuation of the cluster base shrimp farming, production of prawn PL with a view to produce all male prawn PL, development of pathogen screening protocol for OIE listed pathogens and identification of genetic diversity of prawn among the major sources of the country. Following the success of the first-year trial, the stocking density was increased in the second-year intervention. In the last year trial, shrimp production was 780kg/ha with a stocking density 3PL/m² which was 850kg/ha with a stocking density of 6PL/m². This year, the stocking density was increased to 6PL/m² and 9PL/m² to evaluate if it can increase the production without using aeration. All male prawn PL has a great demand among the farmers because of fastest growth rate. It can be achieved by ablation of androgenic gland of known age (50-60 days old PL) prawn PL. For this, prawn PL production activity was started in the prawn hatchery of the station. Disease screening is another important part of successful aquaculture. Under this sub-project, 9 pathogen screening protocols were developed out 11 OIE listed shrimp pathogen. To identify the genetic diversity of prawn among the major sources of the country, sampling of the prawn has been completed, now PCR optimization is ongoing in the laboratory. The main problem of this year was the outbreak of COVID-19 pandemic. Due to lockdown condition and siege of international transport, field sampling and supply of essential reagents were greatly hampered. Therefore, some experiment had to start with delayed scheduled.



KU component: The major objectives of KU component on second year (July 2019 to June 2020) research was to intensify freshwater prawn (*Macrobrachium rosenbergii*) culture increasing the stocking density in non-aerated and aerated culture systems applying probiotics. In this stage, investigation was done on the growth and production performance of prawn under three different commercial probiotics at three stocking densities in non-aerated and aerated culture systems. The stocking density in non-aerated ponds was 2, 4 and 6 m², and in aerated ponds were 4, 8 and 12 m². Three probiotics were selected based on the performance of first year experiment. Probiotics-1(P1) applied as both Feed and Environmental probiotics, P2 as feed probiotics and P3 as Environmental probiotics. The composition of 3 Probiotics are as follows: P1- *Bacillus mesentericus* 9 × 10⁹ CFU, *Bacillus subtilis* 10 × 10⁹ CFU, *Bacillus licheniformis* 9.8 × 10⁹ CFU, *Lactobacillus acidophilus* 7.5 × 10⁹ CFU, *Nitrobacter* sp 8 × 10⁹ CFU, *Nitrosomonas* sp 3 × 10⁹ CFU, *Aspergillus oryzae* 9 × 10⁹ CFU and *Saccharomyces cerevisiae* 9 × 10⁸ CFU; P2: *Streptococcus faecalis*, *Clostridium butyricum* *Bacillus mesentericus*, (over all bacterial load 1.10 × 10⁶ CFU/g; and P3: *Bacillus subtilis* (1 × 10⁶ cfu)&Bacteriophage q.s. to 1 g. In case of non-aerated system, production using P1 were 895.68, 1274.28 and 1292.71 kg/ha at the stoking of 2, 4 and 6 m² respectively. Stocking density 4/m² could be suggested for probiotic based non-aeration culture system considering cost and benefit. Similarly at aerated culture system the production were 1494.66, 1905.09 and 2061.70 kg/ha respectively at 4, 8 and 12m² respectively at same probiotics (P1) treated group. Stocking density 8/m² could be suggested for probiotic based with aeration culture system considering cost and benefit. In both without aeration and with aeration all three probiotics (P1, P2 and P3) treated prawn showed higher production than the without probiotic. Probiotic-1 (P1) showed higher growth, survival and production performance in both non-aerated and aerated treatments compared to P2 and P3.

The proximate composition data showed that prawn treated with P1 had the higher protein content at the stocking density 4 m² compared to 2 and 6 m². However, there were no distinct differences of protein and lipid values among cultured prawn in three probiotics and without probiotic. All three probiotics treated prawn showed higher protease, amylase and lipase enzyme than the without probiotic treated prawn. Probiotics could increase protease, amylase and lipase enzyme activity in prawn. P1 showed little bit higher enzyme activity than P2 and P3. Stocking density has no distinct effect on enzyme activity among the three probiotics. Protease was found higher in 4/m² and amylase in 2/m². Disease challenge test was done applying *Vibrio* spp. in both with and without probiotics in three Medias. The colony of *Vibrio* spp. was found higher in without probiotic (C) than in three probiotics (P1, P2 and P3). Probiotic could inhibit the growth of pathogenic bacteria *Vibrio* spp. The survival (%) of shrimp larvae with the application of *Vibrio* spp. also tested in three probiotics (P1, P2 and P3) and without probiotic. All three probiotics treated prawn showed comparatively higher survival rate against pathogenic bacteria *Vibrio* spp. The immune enzyme assessment data revealed that Pro-Phenoloxidase (Pro-PO) and Superoxide Dismutase (SOD) concentration were higher in probiotic treated prawn than without probiotic, which reflected the higher immune response in probiotic treated prawn (Fig. 6). Among three probiotics (P1, P2 and P3), little bit higher Pro-PO and SOD concentration were found in P1.

15. Project Title: Techniques adoption and formulation of guidelines for sustainable management of haor and beel fisheries (ID 035)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka

Implementing organization : SAU, SUST, RU

General objective : To ensure sustainable fisheries development for Haor and Beel community through improved community based management approach

Duration : Jul 2018 - Jun 2021

Budget : Tk: 350,000,00/-

Background: The North-East region of Bangladesh is blessed with a special type of inland water ecosystem called as 'haor' and rich with plenty of fisheries resources from the time immemorial. The haors are enriched with various aquatic biodiversity along with 140 species of fish. Kura River is a 15 km long connecting canal between Aral beel, a part of Hakaluki Haor and Dhamri Haor with rich aquatic biodiversity. Again, Aral beel and Dhamrihaor is connected with Kushiara River. Sari-Goyain River is another important river with rich biodiversity originated from Assam, India and comes through Japhlong area of Sylhet. Considering the importance of these wetlands the study has been designed to identify the causes of water pollution, impact of climate change on the bio-diversity of the water bodies of the study areas, nature of losses of bio diversity, socio-economic conditions of fishers and to conduct aquatic ecosystem management involving respective communities to enhance aquatic biodiversity as well as increase fish production and reduction of poverty of the fishers. The Chalan beel is the largest and most important watershed in Northern part of Bangladesh. The watershed serves about 5 million people, predominantly through fisheries and agricultural activities (Hossain et al. 2009). Present project will investigate and recommend suitable techniques for increased fish diversity and production and improved livelihood through building fisher's capacity and developing effective sanctuary and caged fish farming in Chalan beel areas.

Progress: The sub-project is an ongoing coordinated project implementing jointly by Sylhet Agricultural University (SAU), Shahjalal University of Science and Technology (SUST) and Rajshahi University (RU) under the coordination of Fisheries Division, BARC. The project has been started functioning in July 2018 and successfully completed its 2nd year activities.

SAU component : Field data on biodiversity and production were collected by direct catch assessment, personal interviews, focus group discussions, and key informant interviews using well-structured questionnaire and checklist. During catch assessment, total 68 species of fishes were observed in catches in the Shari-Goyain River where maximum number of fish species was found during the month of October (49) followed by September (47), August (44), November (41), July (36), December (35), January (32), June (30), February (28), March (25), and May (23). The catch data analysis revealed that 10 main species contributed 64.06% of the total catch by weight where *Mystus cavasius* (19.046%) is the highest contributory species followed by *Wallago attu* (9.358%).



Operation of plankton net

In case of plankton analysis, only 33 genera of phytoplankton and 11 genera of zooplankton were identified from the selected sampling spots. Hydro-chemical parameters of this river were found to be within the suitable range for the survival of aquatic fauna though some hydro-chemical parameters of water were sometimes exceeding the suitable limits, especially in pre-monsoon season. For instance, in several places of the river water pH values were found much below the lower limit of suitable range. Local fishers claimed the coal mine pollutants from the upstream as the main cause of water quality deterioration. Fishers' perception also revealed by the result of the species-specific sensitivity test results. In the tested fish samples mean concentration of Cu, Cd, Fe, Pb, and Zn found to be higher than Food and Agriculture Organization (FAO)/(WHO) tolerable concentration limit.



Cage culture in Ratargul Swamp Forest

Two sanctuaries and two pens have been established in the study area to enhance fish biodiversity. During February/March 2020 repair works were done to keep the sanctuary more effective. According to fishers' statement and catch monitoring data, mola, dhela and other small indigenous species (SIS) of fishes have been increased in the Ratargul Swamp Forest and in the Gurukchi River as well as in adjacent waterbodies after implementing the activities of this ongoing project. As an alternate livelihood options of the fishers' a total of 9 cages were set up inside the Ratargul Swamp Forest and 9 cages in the Gurukchi River of Gowainghat upazila, Sylhet. According to the findings of 1st experiment pangas was selected for the research at Ratargul Swamp Forest and tilapia was introduced for Gurukchi River. In case of pangas a significant effect ($P < 0.05$) of stocking density on growth performance was observed. Overall result of the study indicated that 30 fish/m³ stocking density of pangas is the best among three treatments. In case of tilapia a significant effect ($P < 0.05$) of stocking density on growth performance was also observed. Overall result of the study indicated that 60 fish/m³ stocking density of tilapia is the best among three treatments. Therefore, in future for the local farmers pangas with 30 fish/m³ and tilapia with 60 fish/m³ stocking density could be suggested for cage aquaculture in order to get sustainable production and higher economic return in a short period of time.

SUST component: It has been working on Shari-Goyain River an important water body with rich biodiversity, originated from the hilly areas of the Meghalaya State of India. There is an adverse impact of coal mining comes through run-off from Meghalaya, India which is one of the main reasons of loss of biodiversity. In addition, siltation, frequent flash flood, river bank erosion and other natural disasters have impact on the production of fish in the river. Laboratory experiments are conducted for determining water quality, rate of annual siltation on the river floor is measured on site. Baseline survey has been conducted to know the socio-economic condition of fishers, market access and governance, their understanding about the

conservation of biodiversity and fish production in the study area. Information, Development of Education and Communication (IEC) materials is in progress, they will be printed and circulated among the fishers and local community people for raising awareness on alternative livelihood, fish and fisheries related policies, process of forming fisher's association, climate change, importance of biodiversity conservation etc. Motivational camping is going on and preparation on arranging awareness rally 2 with banners and festoon is in progress with the participation of fishers and local community people on the protection and preservation of biodiversity in the water bodies of the study areas. Kura River in Golapganj Upazila of Sylhet district is an inter-connecting canal between Aral Beel, a part of Hakaluki Haor and Dhamri Haor with rich aquatic biodiversity. Again, Aral Beel and Dhamri Haor are connected with Kushiara River. Therefore, as control site, water quality of Kura River is assessed periodically to understand the differences between the two rivers. Comparison will be presented later in the next half yearly report. It is expected that the project will be able to identify the causes of losses of fish resources, will find ways to reduce water pollution and will contribute in regaining fisheries resources with the active involvement of fishers and local community people. This would also change peoples' behavior on the use of natural fish resources will promote socioeconomic conditions of fishers in the study areas.



SIS fish observed around the sanctuary site of Ratargul Swamp Forest

RU component: It has been implementing the sub - project in Chalan beel areas under two upazilas (Shingra in Natore district and Chatmohar in Pabna district). Findings of baseline survey indicated lacking in monitoring and renovation of the existing sanctuary were the main causes of lower performance in Chalan beel area. Complete dewatering of comparatively shallow region of the beel was also responsible for the degradation of fish diversity. However, construction of sanctuary using potential materials like hexapod and ring pipes result in a new dimension to the conservation of fish diversity in this beel. Established sanctuaries have caused a tremendous environmental improvement in the sanctuary area. Not only environment but also the fisheries diversity has increased and become stabilize due to the construction of sanctuaries in both of the study area. Moreover, comparative study conducted to evaluate the performance of present project implemented sanctuaries to boost up fisheries diversity showed that both species abundance, richness and diversity were higher in present sanctuary sites (experimental sanctuary) compared to DoF implemented partially protected site and open site (free from sanctuary or any other exerted fishing ban). 10 types of potentially important fish species which was less available (Botia dario, Botia lohachata, Ompok pabo, Rita rita, Cirrhinus reba, Clupisoma garua, Sperata aor, Eutropiichthys vacha, Puntius sarana and Mystus cavasius) being stocked in the two sanctuary sites with different densities were also found in higher abundance in the experimental sanctuary sites than other comparing study sites. Occurrence of these species were less or completely absent during our baseline survey. But after establishment of well-structured sanctuaries (hexapods, ring pipes etc.), these species is now in regular appearance in the sanctuary sites. However, comparative study with other two sites also indicated improvement of stocked species abundance in present sanctuary sites. However, during the reporting year flooding caused little damages in some bamboo poles in both sanctuary and it has been repaired. The technique of using hexapod and ring pipes in present sanctuaries were proved beneficial for



Purchasing of fry

increasing fish diversity in chalan beel area. In the otherhands, sanctuaries established earlier did not used hexapods and ring pipes and they become disappear during flooding season. Followed by the first year experiment of cage culture as alternative option during ban period of fishing in sanctuary areas suggested Gulsa tengra was the most suitable fish spesces for cage farming in Chalan beel area. Therefore, for the second year cage farming trial (selection of suitable stocking density of Gulsa tengra for cage culture system in Chalan beel), 4 potential stocking densities (50, 100, 150 and 200 fish/m³ cage) were selected with three replicate of each density. In this experiment, four treatments were assigned as T1 (50 fish/m³), T2 (100 fish/m³), T3 (150 fish/m³) and T4 (200 fish/m³). Gulsa tengra with an initial body weight of 5.55±0.49g were released in the experimental cages (6 m x 3 m x 2 m). Post stocking management such as feeding, water quality monitoring, light providing at night and monthly growth monitoring were done accordingly. After the four months of culture period, total and net productions were found higher for the stocking density of 150 fish/m³ cage at T3. But in case of economic analysis, it was found that total income, net income and BCR were highest for the treatment T2, where the stocking density of fish was 100 fish/m³. So, it is recommended that Gulsa tengra with a stocking density 100 fish/m³ is a good option for cage fish farming in Chalan beel area which will be economically viable.

16. Project Title: Post-harvest losses, supply and value chain analysis of fisheries sub-sector in Bangladesh (ID 036)

Coordinator	: Member Director (Fisheries), BARC, Farmgate, Dhaka
Implementing organization	: BARC, BAU, PSTU
General objective	: To assess post-harvest losses in each nodes of supply and value chain of capture, culture and marine fisheries in Bangladesh
Duration	: Dec 2017 - Jun 2021
Budget	: Tk: 3,77,03,559/-

Background: Fisheries sub-sector contributes 3.69% to the Gross Domestic Product (GDP), 22.60% to agricultural GDP and 2% to the foreign exchange earnings (BBS 2016; Ministry of Finance 2015). Post-harvest loss of fish in Bangladesh is also enormous. About 20- 30% in different fish and fishery products losses after harvesting, and 50 % reduction of such loss can save Tk.8,000-10,000 crore per annum (Nowsad at el. 2015, Nowsad, 2010). A problem in the supply chain for fish in Bangladesh is that the knowledge about post-harvest handling is limited and post-harvest losses are high. Losses occur in all post-harvest activities such as handling, storage, processing, packaging, transportation and marketing. Long distance between production and consumption areas is also one of the main causes of post-harvest losses. Post-harvest losses occur within the whole supply chain due to limited resources such as post-harvest technology, knowledge and infrastructure (Parfitt et. al 2010). Analysis of post-harvest losses, supply chain and value chains requires detailed micro-level data. But there is no countrywide in-depth study on these issues. Previous research works provide only the amount of losses and supply chain of some specific species in a specific area. Thus, the present study will be conducted to generate countrywide information on post-harvest losses, supply chain and value chain structure of capture, culture and marine fisheries which will enhance production, processing and marketing of different species of fishes and reduces post-harvest losses of fish in Bangladesh.

Progress: Bangladesh Agricultural University (BAU) and Patuakhali Science and Technology University (PSTU) jointly conduct this research. Both components (BAU and PSTU), data and necessary information were collected from primary and secondary sources covering all 64 districts. Considering the conveniences the study area divided between BAU and PSTU component. BAU component covered four divisions viz. Dhaka, Rangpur, Rajshahi and Sylhet. PSTU covered Dhaka (5 districts), Barishal, Khulna and Chattogram divisions. PSTU component covering capture, culture and marine fisheries under these four divisions. The BAU component selected 14250 (apprx) samples following multi-stage stratified random sampling technique from 32 districts of Dhaka, Rangpur, Rajshahi and Sylhet division. Total sample are divided into culture and capture fisheries based on the share of production according to DoF statistics (DoF, 2015-2016). A set of survey questionnaires were developed and pre-tested in Mymensingh, Kishoreganj, Sirajganj, Rajshahi, Pabna and Natore district for capture and culture fisheries, and associated markets. To date, 1661 respondents from different stakeholders were interviewed by the enumerators.

As regards on the progress of data collection during the period from January to December 2019, out of 10688 samples approximately, 5284 number of samples of different types of respondent (including 1391 sample for fisher, 1180 fish farmer and 2723 as traders) were collected by BAU which was about 49.4% of the total samples. While a total of 6902 samples were collected by PSTU out of 14345 samples (including 1813 fisher, 1240 fish farmer and 3849 as traders) which was about 48.11% of the total sample. Out of 37 number of FGD, a total of 11 number of FGD were conducted by BAU component, but a few number of FGD so far conducted by the PSTU component. Several coordination meetings/Half Yearly progress review workshop/ Annual review workshop etc were conducted by Coordination Component of BARC over the year.

Table 3.10: Data collection information

Sl #	Name of Divisions	Fisher (Capture/Marine)	Fish farmer (Culture)	Trader			Total
				Arotdar	Paiker	Retailer	
1	Barisal	453	256	103	221	580	1613
2	Dhaka	240	160	30	98	190	718
3	Khulna	498	531	189	345	712	2275
4	Chattogram	622	293	201	377	803	2296
Total		1,813	1,240	523	1,041	2,285	6,902

A partial result presented by PSTU indicated that, post harvest losses were found highest for marine fisheries (11.67%) followed by captures (7.01%) and culture (4.47%) fisheries. On the other hand, among the intermediaries retailer added highest value of culture fish and lowest was arathdar. In addition, wholesaler added highest value of capture fish and lowest was arathdar as well as marine fish salting processor added highest value by processing the hilsa fish followed by dried processor, retailer, wholesaler and arathdar, respectively.

Table 3.11: Post harvest losses of fish resources per metric ton

Fishe source	Weight loss (kg)	Quantity of degraded fish (kg)	Total loss (Tk)	All
Culture fish	15.131	113.468	11194.72	11323.32
Capture fish	21.75	147.721	31536.64	31706.11
Marine fish	41.18	177.377	27812.2	28030.76
All	78.061	438.566	70543.56	71060.19

17. Project Title: Improvement of existing fattening technology of carp and high valued small indigenous species (SIS) through good aquaculture practices (GAP) in different agro-ecosystems (ID 037)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka

Implementing organization : RU, PSTU

General objective : Improve food security, income and livelihoods of fish farming community through enhanced training and capacity of the entrepreneurs/farmers by developing sustainable carp fattening and SIS fish farming following good practices along with live fish transportation technique and marketing strategies and promoting viable solutions to market constraints

Duration : Dec 2017 - Jun 2021

Budget : Tk:3,79,98,612/-

Background: The fisheries sub-sector of Bangladesh as an important component of agricultural activity consider as the most potential source of economic and employment generation and a vital source of animal protein provider, as well. The sector is highly diverse in resource and species type. In the recent years though there has been a steady and rapid growth of aquaculture and fish food production, income generation and livelihood improvement of fishers but in spite of that there still prevails/exists fish production gap in the country which has been widening every year because of higher population growth rate. The scientist community and the policy makers of the country indicate the weakness in research capacity of the institutes and research-extension linkage are the two most vital and responsible causes for this. Thus to address the situation through establishing strong research support and linkage, as NATP-II thoughts, all research and extension institutes need to make strong footing with team building holistic research culture to achieve desired output. With this consideration, as an effective approach, the Program Based Research Grant (PBRG) of NATP-II is particularly aimed to support coordinated research program amongst NARI to jointly combating national agricultural problems and strengthening the research and research management capacities of the institutes. Therefore, under the principal objective of NATP-II, the fisheries division co-ordination component shall have to play the role to ensure smooth and efficient implementation of sub-project activities to achieve the desired project output through coordination of activities and strong and effective monitoring of research progress under an additional increased research support against each institute.

Progress:

RU component: Lack of guidelines in selecting appropriate stocking size, density and combination of species are major constraints for fish production through carp fattening and SIS-carp polyculture in drought prone barind area of Bangladesh. In order to address these problems, efforts (based on the findings obtained from the experiments in 2018) are taken to conduct two separate experiments in 2019 as experiment-1 on “Optimization of stocking density for carp fattening in ponds under drought prone area” and experiment-2 on “Optimization of stocking density for farming of SIS fish (Magur, *Clarias batrachus*) in homestead ponds under drought prone area”. Experiment-1 on carp fattening had three treatments of stocking densities like T1: 2470 fishes/ha



Study on water quality, fish growth and GAP aspects

(10 fishes/decimal); T2: 3705 fishes/ha (15 fishes/decimal); and T3: 4940 fishes/ha (20 fishes/decimal), each with three replications. Experiment-2 on SIS-carp polyculture had also three treatments of stocking densities of magur, *C. batrachus* like T1: 37,050 fishes/ha (150 fishes/decimal); T2: 74,100 fishes/ha (300 fishes/decimal); and T3: 111,150 fishes/ha (450 fishes/decimal), each with three replications. Thus a total of 36 ponds as core trials under two upazilas (Paba and Tanore) of Rajshahi (drought prone area) district are selected for conducting these experiments with a view to recommend suitable stocking densities for carp fattening and SIS-carp polyculture ponds. In case of experiment-1, overwintered carp species (surface feeder: catla, *Gibelion catla* and silver carp, *Hypophthalmichthys molitrix*; column feeder: rui, *Labeo rohita*; bottom feeder: mrigal, *Cirrhinus cirrhosus* and common carp, *Cyprinus carpio*) and their combination (40% surface feeder, 30% column feeder and 30% bottom feeder) is same for all the treatments. In case of experiment-2, co-species of SIS fish (silver carp, *H. molitrix*-2/decimal, catla, *C. catla*-1/decimal and rui, *L. rohita*-1/decimal) is same for all the treatments. Supplementary feeding strategy (25% protein feed for carp fattening and 35% protein feed for SIS fish) is same for the treatments under the experiments. Efforts are taken to take data on water quality, fish growth, economics and GAP aspects. A standard format (pond record book) is also developed for collecting the data during six months fish growing period from the experiments. Experimental findings indicated that treatment T1 (lowest stocking density) was found best in carp fattening. In case of experiment on SIS-carp polyculture, treatment T2 (Magur, *C. batrachus* based carp farming with medium stocking density) was found best over others. Further research is also recommended with emphasis on the effect of supplementary feed on the production and economics of carp fattening and SIS-carp farming in ponds under drought prone area.

PSTU component: With the same objective, but in different ecosystem, the PSTU component set experiment to improve fattening technology of carp and high valued SIS for the period of January 2019 to December 2019. In 1st trial, the fish were collected from each experimental pond manually after draining out the water from the ponds. The collected fish were then counted and the number was recorded separately pond wise. The highest production (4078.52 ± 148.32 kg/ha) and CBR (0.43) was achieved in treatment 3 where 35% surface feeder, 35% column feeder and 30% bottom feeder carp fishes were stocked. Among SIS species, the highest production (3289.52 ± 372.44 kg/ha) and CBR (0.53) was recorded from magur. All the water quality parameters were found within suitable ranges. In 2nd trial, two experiments are being conducted at Kalapara upazila under Patuakhali district. The title of experiment1: Optimization of stocking density for carp fattening in ponds under coastal area. 2: Optimization of stocking density for farming of SIS fishes in homestead ponds under coastal area. The ponds were prepared as per standard pond preparation protocol. Carp and SIS fingerlings were collected from Jashore and stocked in the experimental ponds. Artificial feed are being used for feeding the fingerlings. Water temperature ($^{\circ}\text{C}$), dissolved oxygen (mg/l), salinity (ppt), pH and Total Dissolved Solids (TDS) (mg/l) are being determined monthly by HQ 40D Multimeter. Free carbon dioxide (mg/l), ammonia-nitrogen (mg/l), nitrate- nitrogen (mg/l) and alkalinity (mg/l) are being measured monthly by HACH kit (FF2, USA). Plankton concentration in water is being determined as per standard method in monthly. Growth parameters like length, weight data etc. are being monitored fortnightly. For strengthening capacity building of fish farmers a training program was conducted in the study area.



Feed application at pond

18. Project Title: Microbial characterization of Bangladesh soil and development of climate smart biofertilizers for crop production and soil fertility (ID 043)

Coordinator	: Member Director (NRM), BARC
Implementing organization	: BARI, BRRI, BINA, BSRI
General objective	: To study physical, chemical and microbial properties of soil of different AEZs of Bangladesh; to isolate climate smart i.e. saline, acidic and drought tolerant Nitrogen-fixing and plant growth promoting bacteria from root, nodules and rhizosphere soils of Bangladesh and to develop biofertilizer for pulse, oilseed, sugarcane and test their efficiency for crop productivity and soil fertility.
Duration	: Oct 2019- Jun 2021
Budget	: Tk2,70,67,000/-

Background: Due to global climate change, agriculture needs to change in its structure. Crops production system requires climate suitable plant nutrition and soil management practices. The interaction between plants, soil and microorganisms is considered to be the major driver of ecosystem functions (Suleiman et al., 2013). Improved understanding of the soil microbiome will help identify management practices to optimize soil functions e.g. nutrient availability, optimize fertilizer practices and reduce environmental impacts of farming. Physico-chemical properties of soils of Bangladesh have been documented, but very little information is available on microbial community structure and dynamics, and their interactions with soils and plants. Long-term indiscriminate use of agrochemicals and the changing climate affect soil microbial diversity resulting in an adverse soil health and lower resource use efficiency, crop productivity and sustainability. It is reported that total bacteria, urease and phosphatase activities, population of ammonia-oxidizing bacteria (Ali et al., 2013), methanotrophs (Dai et al., 2013) and denitrifiers (Tang et al., 2010) shifted due to long-term chemical fertilizer applications. The microbial populations of Bangladesh soils vary from AEZs to AEZs (Bhuiyan et al., 2015). Proposed project will greatly increase our understanding of the underlying microbial processes underpinning nutrient biogeochemistry in soils under diverse crops and cropping patterns, and will help optimize nutrient use efficiency, improve resilience to climate change, and refine greenhouse gas mitigation options.

Soil salinity is increasing in costal saline areas day by day. A vast area of Noakhali, Chittagong, Khulna, Satkhira, Bagerhat, Bhola, Barisal, Barguna, Patuakhali are now affected by salinity. Some areas like Madhupur and a part of hilly areas are highly acidic. Western part of country i.e. Chapainawabgonj and part of Rajshahi district is going under drought prone belonging high temperature and low moisture regime. Stress tolerant crop varieties are being developed for cultivation in that area. But there is no such soil management practice for plant nutrition system. Biofertilizers can function as key player in sustainable crop production by improving soil fertility, plant tolerant and crop productivity. Biofertilizers such as N- fixing, P- solubilizing and quick composting are very important tools for crop production and fertility sustaining in that areas. These stress tolerant potential endospheric and exospheric (N-fixing, P solubilizing) bioinoculants smartly work in that soils for better crop production and soil fertility management. This is the high time to formulate potential climate smart bioinoculant for cereal, pulses and oil seed crop production and soil fertility sustaining.

Progress:

BARI component: collected soil samples from different cropping pattern from 2 AEZ's ie, AEZ 13 (Khulna), AEZ 18 (Patuakhali) and AEZ 24 (Saint Martin's Coral Island) and rest of AEZ soil samples will be collected with in October 2020. Identifying soil characteristics like organic, total N content, soil pH, soil EC were analyzed and soil texture analysis are going on. Beneficial and plant growth promoting (PGPB) bacteria were isolated and identified from 50 soil samples. Soil microbial population characterization was done upto 50 soil samples. Soil pH ranged from 5.56 to 9.95 found lowest in Bodorpur, Patuakhali and the highest in Dheukhali, Laukathi, Patuakhali soil; organic carbon ranged from 0.50% to 1.10% with lowest in Charvanga, Tilvanga, Dacope, Khulna and highest in Konar Para, Saint Martin, Teknaf, Cox's Bazar soil; total nitrogen ranged from 0.045% to 0.100% with lowest in Charvanga, Tilvanga, Dacope, Khulna and highest in Konar Para, Saint Martin, Teknaf, Cox's Bazar soil; rhizobial population ranged from 0 to 32×10^7 cfu g⁻¹soil with lowest in Jamla, Srirampur, Dumki, Patuakhali and highest in Giparinagar, Jomla, Batiaghata, Khulna; The soil total bacterial population was ranged from 2×10^4 to 30×10^7 cfu g⁻¹soil with lowest in Giparipara, Jomla, Batiaghata, Khulna and highest in Tolakpara, Amirpur, Batiaghata, Khulna; total fungus population ranged from 0 to 7×10^7 cfu g⁻¹soil with lowest in Amirpur, Batiaghata, Khulna and highest in Srirampur, Dumki, Patuakhali; total Actinomycetes population ranged from 0 to 10×10^7 cfu g⁻¹soil with lowest in Char Chalna, Pankhali, Dakup, Khulna and highest in Tilvanga, Dacope, Khulna. The soil total Phosphate solubilizing bacterial population was ranges from 0 to 22×10^6 cfug⁻¹soil found the lowest in Tilvanga, Dacope, Khulna and the highest in Golachipa, Saint Martin, Teknaf, Cox's Bazar. The soil total free living bacterial population was ranges from 0 to 7×10^7 cfu g⁻¹soil found the lowest in Tilvanga, Dacope, Khulna and the highest in Ghatail, Pankhali, Dacope, Khulna.



Soil sampling at Saint Martin island

BRRi componnet: Soil samples (0-15 cm depth) were collected using GPS recording from AEZ-8, AEZ-21 and AEZ-19 from Kishoreganj and Cumilla district, respectively. Bacteria, fungus and actinomycetes populations were grown in specific media and enumerated using spread plate count method. Study report showed that the soils of Sutarpa union of Karimganj, Kishoreganj have plenty of total bacteria, phosphate solubilizing bacteria and rhizobium compared to AEZ-19 and AEZ-8. However, AEZ-19 soil is rich in free living N₂ fixing bacteria. The soils of Uttar Pirujpur union of Bazitpur, Kishoreganj (AEZ-8) is poor in soil biology compared to other two tested AEZs. Determinations of soil chemical properties are in progress.

BINA component: To observe the microbial i.e. bacterial and fungal population in soils of Moazzempur union of Nandail Upazilla of Mymensingh under AEZ- 9 (Old Brahmaputra Floodplain soil) sueface soil of six village named Kaliapara, Kadirpur, Dattapur, Kmalpur, Atkapara and Uttar palahar were studied. Result revealed that Dattapara soil showed the highest bacterial population among the six village soils while fungal population was found highest in Kamalpur area. The lowest bacterial population was recorded in Kaliapara. Bacterial population ranged from 3.2×10^{-6} to 1.3×10^{-7} cfu g⁻¹ soil. Fungal population was found with the range of 1.3×10^{-4} to 1.1×10^{-5} cfu g⁻¹ soil in Nandail Upazilla. A total of 15 Rhizobial strains were isolated from saline soil of Subarnachar of Noakhali and Deohata of Satkhira district. They will be characterized biochemically and nodule formation, nitrogen fixation, plant growth and yield performance on host plant soybean.

BSRI component: Among seven AEZs (AEZ 1, 4, 5, 8, 21, 28 and 20) soil collection has been done from 3 AEZs viz., AEZ 1, 4 and 5. From each AEZs two location (union) was randomly selected under one Upazilla. From each location ten soil samples were collected. Thus from two location 40 soil samples were collected. From the collected soil samples enumeration of total bacteria, fungus and actinomycetes were done. Results revealed that in AEZ 1 Bacteria, Fungus and Actinomycetes population ranged from 6.2×10^{-6} to 20.0×10^{-8} cfu g⁻¹ soil, 4.5×10^{-4} to 10.0×10^{-5} cfu g⁻¹ soil and 3.2×10^{-6} to 6.0×10^{-7} cfu g⁻¹ soil, respectively. In AEZ 4 Bacteria, Fungus and Actinomycetes population ranged from 5.8×10^{-7} to 6.4×10^{-8} cfu g⁻¹ soil, 3.8×10^{-4} to 8.6×10^{-5} cfu g⁻¹ soil and 5.3×10^{-6} to 6.3×10^{-7} cfu g⁻¹ soil, respectively. In AEZ 5 Bacteria, Fungus and Actinomycetes population ranged from 4.5×10^{-6} to 9.5×10^{-8} cfu g⁻¹ soil, 3.8×10^{-4} to 8.6×10^{-5} cfu g⁻¹ soil and 3.5×10^{-6} to 7.0×10^{-7} cfu g⁻¹ soil, respectively. A field experiment entitled 'Screening of sugarcane genotypes for biological N₂-fixation by free-living and associative bacteria in N-stressed field condition' was conducted at four locations viz., BSRI Farm (AEZ-11), Ishurdi, Pabna; RSRS Farm (AEZ1), Thakurgoan; RSRS Farm (AEZ 28), Gazipur and BSRI Jamalpur Substation Farm (AEZ 9), Jamalpur to isolate promising bacteria for making biofertilizer for sugarcane. Sample collection of rhizosphere soils with root and shoot of sugarcane from two experiment plot was completed.



Screening of sugarcane genotypes for biological N₂-fixation at Thakurgoan

19. Project Title: Adaptation and scaling up agroforestry for livelihood improvement of farmers in agricultural ecosystem of Bangladesh (ID 049)

Coordinator : Chief Scientific Officer, On-Farm Research Division, BARI, Gazipur

Implementing organization : OFRD, BARI, Gazipur; OFRD, Pabna; OFRD, Rajshahi; OFRD, Rangpur; OFRD, Patuakhali; OFRD, Bandarban

General objective : Farmers livelihood improvement and ensuring food security through adoption of innovative agro-forestry technologies.

Duration : Dec 2017- Jun 2021

Budget : Tk10000000

Background: Agroforestry system can contribute stable income, food and nutrition security, savings and insurance and apotentialmeans of risk management under climate change induced stress (Akteretal.1989; Evans1988). At present there search addressing soil and water conservation, reduce soil erosion,livestock feed management, fuel energy, tree-crop interaction for higher productivity and environmental benefit under integrated agroforestry system are getting high priority to combat climate change challenges (SAC,2015). In hill ecosystem, agroforestry (contour hedge rows) on steep hill slopes (40-50%) can reduce soil erosion by 55-80% and runoff by 30-70% compared to shifting cultivation (Khisa,2001). BARI developed MultiStrata Fruit Orchard (MSFO) found suitable for preventing soil erosion and degradation and increased cropping intensity in hill areas (Paul and Hossain,2001). On-Farm Research Division of Bangladesh Agricultural Research Institute (BARI) has developed homestead based agroforestry model through holistic approach in its 9FSRD sites in different ecosystem increased production (50.93 and 146.56%), food intake (68.67 and 124%) farm net

income (326% and 115%) from homestead agroforestry with year-round vegetables and fruits respectively over existing farmers practice (OFRD, 2015). Presently the research on screening of crops and their management under the niche of rapidly growing fruit orchard in rural areas is gaining increasing demand by the farmers.

The Bangladesh Agricultural Research Council (BARC) has identified new potential area of agroforestry research and development at cropland, homestead, hill, coastal, rainfed and charland under different ecosystem and given priority on coordinated research aiming food and nutrition security of peoples in those stress environments. Therefore, the proposed research concept is designed to conduct research aiming to find out innovative technologies and dissemination of developed agroforestry in different ecosystem of Bangladesh.

Progress: The sub-project is initiated under On-farm Research Division (OFRD), BARI with an aim to develop innovative agroforestry technologies; their adoption and eventual livelihood improvement of farmers through enhance productivity and economic return at different locations representing Plain land, Rainfed, Coastal and Hill ecosystem. OFRD, BARI component has started agroforestry activities in five (05) different locations namely Pabna, Rangpur, Rajshahi, Patuakhali and Bandarban through their management units of FSRD and MLT sites during January to December 2019. The research areas were (i) Homestead production system, (ii) Crops and cropping system, (iii) On-farm verification and (iv) Production program in agroforestry system. All components of integrated farming such as vegetables, fruits, cropping patterns in agroforestry system were brought under improved technological intervention and accordingly income was increased from these components. Two-three villages have been considered under agroforestry activities irrespective of locations. On the basis of PRA and base line survey report, farmers need based technologies were intervened among small, marginal and small farmers. OFRD team has established some agroforestry activities with the high value crops (Cabbage, Cauliflower, Tomato, and Broccoli etc.), pulse crops (Lentil and Grass pea) and oilseed crop (Mustard) in the selected mango, guava and litchi orchards at field level. At FSRD site, Ganggarampur, OFRD, Pabna high value crops like cauliflower, tomato and cabbage were introduced in guava based agroforestry system during rabi season of 2019. Maize, sweet potato, boro rice, winter vegetables and fodder crop like napier grass has grown in fruit based (Mango, Litchi) orchards under different cropping patterns at FSRD sites, Ojoddapur, Rangpur Sadar, OFRD, Rangpur. Different pulse crops (Lentil, Grasspea and Chickpea) have grown in association with mango orchards in Rajshahi. In Patuakhali, different vegetables have grown in association with homestead trees, roadside trees and sorjan based fruit trees. In Bandarban, different creeper vegetables were grown in association with fruit trees in the hill slope. Spices crops such as turmeric and ginger were planted under the niches of fruit orchards in the hilly areas. The activities under this sub-project seem encouraging for the farmers of different locations. However, rapid expanded fruit tree based orchards are opening good scope for agroforestry based intensive production results in incremental yield and economic return per unit area. Year round homestead vegetables and quick growing fruits production, cropping patterns (at FSRD sites, Barind station, Rajshahi: Lentil-Mungbean-T.Aman rice, and Chickpea-T. Aman rice cropping pattern and at FSRD site, Rangpur: Maize-T. Aus rice- T. Aman rice pattern) were developed in agroforestry system. In addition, different pulses were cultivated in mango based agroforestry system. It is revealed that vegetables production increased by 166% after sub-project intervention, where intake of vegetables was markedly increased (avg. 147%) as compared to before intervention (60 kg per farm family per year) by all families included in this system. Existing fruit tree management has created a good impact on farm households. Performance of chickpea and lentil was



Litchi based agroforestry systems at Pabna

Performance of chickpea and lentil was

superior among the pulses in mango based agroforestry system. Cropping patterns like lentil-mungbean-T.aman, and chickpea-T.aman rice had higher productivity in mango based agroforestry system over sole mango system at FSRD site, Barind, Rajshahi. The sub-project activities revealed that inclusion of high value crops and vegetables not only increased the production and consumption but also utilize the fallow lands under the fruit trees after sub-project intervention. Existing fruit tree management has created a good impact on crop production as well fruit production. Performance of maize and T. aus was superior than existing cropping patterns in mango based agroforestry system was compared with sole mango system. The results of agroforestry activities imply that by implementing the program at FSRD site has created an opportunity to improve livelihood of the resource-poor farmers.

20. Project Title: Validation of crop intensification technologies for improving system productivity, soil health and farm income in south central coastal region (ID 051)

- Coordinator** : Director (Res), BARI, Joydebpur, Gazipur
- Implementing organization** : Soil Science Division, BARI; Oilseed Research center, BARI and Agrarian Foundation, House # 48, Road # 5, Pisciculture Housing, Mohammadpur, Dhaka- 1207
- General objective** : Increasing farm income through intensive crop production and improving farmers' knowledge and skill through training, conducting on-farm trials and demonstrations on improved agricultural production technologies in south central coastal region.
- Duration** : Oct 2018 - Jun 2021
- Budget** : Tk: 1,56,25,000/-

Background: Coastal agriculture relies heavily on rainfall and tidal water. Irrigation remains scarce. Rainfall is becoming more erratic probably because of climate change. High rainfall variability and recurrent drought/flood cycles disrupt food production, particularly where crops are grown in marginal lands with low inputs. Sea level rise and increased frequency of storm surges are aggravating the problem of coastal flooding, hitting the most vulnerable hardest. Bangladesh in general and coastal region in particular is vulnerable to climate change. Impact of climate change is increasingly visible through frequent cyclones and tidal surge that damage crops, properties, and lives imposing additional stresses to already delicately balanced agro-ecosystems. Vulnerability of rice production to climate change in the coastal regions have been documented. Given the current prediction of temperature increase and sea level rise, there will be a substantial decrease in future agricultural productivity in the region. It is against this backdrop climate resilient agricultural production system needs to be developed. Adapting to climate change and stimulating agriculture to drive development require greater agricultural research, integration of natural resource management into agricultural production, knowledge, education and skill development, and use of collective action to organize, engage and drive rural communities into production. This research sub-project seeks to gain better understanding of the bio-physical and socio-economic factors constraining and promoting crop production, developing and adopting better crop production technologies in order for increasing agricultural production and improving rural economy in selected six southern central districts. The sub-project proposal is in line with the governmental policies, objectives and strategies of improving agricultural production. This sub-project was developed in order for increasing cropping intensity in the south central coastal region incorporating dry season crops (grasspea, mungbean and sesame) in fallow-transplanted aman rice system. Beginning Jan 2019, the sub-project is being implemented by two components of BARI i.e. Soil Science

Division and Oilseeds Research Center, and Agrarian Research Foundation (ARF) under the leadership of Director Research, BARI.

Progress: This coordinated project was implemented jointly by Soil Science Division (SSD) and Oilseed Research Center (ORC), Bangladesh Agricultural Research Institute (BARI) collaborated with Agrarian Research Foundation (ARF) component started from January, 2019. Three components were conducted research on validation of crop intensification of three major cropping pattern in which two cropping pattern were executed in Gopalganj (Gopalganj Sadar, Kasheani upazilla), Madaripur (Madaripur sadar, Kalkini upazilla), Pirojpur (Pirojpur Sadar, Vandaria), and another one pattern was executed in Barishal (Babugonj, Gouronodi), Bagerhat (Bagerhat sadar, Mollarhat) and Jhalakati (Jhalakati Sadar, Rajapur upazilla) for the target of improving system productivity, soil health and farm income. According to the suggestion from the expert members of the Inception workshop, in case of Activity-3, for Groundnut-Gimkolmi-T. Aman cropping pattern, groundnut was replaced by grasspea. The baseline survey was completed for existing crops practiced by the local farmers. After baseline survey, three crop based cropping pattern were introduced like Mustard-Mungbean-T. Aman and Grasspea -Gimkolmi-T. Aman at Gopalganj, Madaripur and Pirojpur region against the existing two or single crop based cropping pattern like Rabi-Jute-Fallow or Rabi-Fallow-T. Aman or Rabi-Boro-Fallow or Boro-Fallow-Fallow. In Barishal, Bagerhat and Jhalakati location, the cropping pattern was Sweet gourd-Sesame-T. Aman.

By June 2019, the Soil Science Division, BARI component conducted experiments starting with the mungbean and gimkolmi crops in Kharif-1 season and harvested with good yields. From the first year trial, it was observed that IPNS based fertilizer application performed better than farmers practice with BARI Gimkolmi-1 yielded 15% higher than local varieties. Among the mungbean varieties, BARI-Mung-6 yielded better than BINA Mung-8 and BARI Mung-8. The second crop T. aman in both the cropping pattern was transplanted in last week of July 2019 and harvested at full maturity in October 2019. Among the three T. aman rice varieties, the variety BRRI dhan 71 resulted better performed than BRRI dhan 57, and BRRI dhan 75 in all fertilizer levels. Mustard and grasspea was sown in Rabi season of 2019 and the crop still growing in field now. For Barishal (Babugonj, Gouronodi), sesame was sown but due to heavy rainfall, the crop was damaged and T. aman was also damaged due to heavy shower caused by the cyclone Aila.

Oilseed Research Centre, BARI component implemented farmer's trial crops sesame in Kharif-1 season and harvested timely with better yields in Bagerhat sadar and Mollarhat upazilla. From the first year trial, it was observed that IPNS based fertilizer application performed better than farmers practice with BARI Till-4 yielded 19% higher than BINA Till-4. The second crop T. aman in this pattern BRRI dhan 71 resulted better performed than BRRI dhan 57, and BRRI dhan 75 in IPNS based fertilizer application compared with farmers practice. Sweet ground was sown in Rabi season and the crop still growing in field now. On the other hand, BARI-Mung-8 yielded better than BINA Mung-8, and BARI Mung-6 in IPNS based fertilizer application in Madaripur and Kalkini upazilla. Another cropping pattern BARI Gimkolmi-1 yielded 13% higher than local varieties. Among the second crop T. aman of three rice varieties, the variety BRRI dhan 71 resulted better performed than BRRI dhan 57, and BRRI dhan 75 in IPNS based fertilizer levels. Mustard and khesari was sown in Rabi season in both pattern and the crop still growing in field now.



Mustard Mungbean-T.aman cropping pattern in Gopalganj Sadar

ARF selected two villages each of Jhalokati and Pirojpur districts for conducting baseline study, experiments and trials on-farm involving farmers. A baseline survey was conducted drawing 16+15=31 farm households in April 2019. Results reveal that nearly 100% farmers in two upazila used to grow transplanted aman rice during wet season while 29% farmers planted dry season crops dedicating smaller areas. Farmers' preferred crops are grasspea and mungbean; but productivity of dry season crops is very low. Unless yield is improved, return will not even equal production cost.

21. Project title: Introduction of profitable and agro-ecologically suitable crop varieties and development of marketing systems for the charlands of borthern Bangladesh (ID-054)

Coordinator	:	Chief Scientific Officer, On-Farm Research Division, BARI, Gazipur
Implementing organization	:	OFRD, Rangpur; OFRD Gaibandha and BAU, Mymensingh
General objective	:	Farmers livelihood improvement through introduce of high value crops and development of marketing system innorthern charland
Duration	:	Apr 2018- Jun 2021
Budget	:	Tk: /- 10000000

Background: Charlands are highly dynamic as they disappear or reappear due to erosion or accretion. Since the chars are formed through the continual process of land erosion and deposition on the major rivers and coastal areas, the whole of the char land is unstable and prone to annual flooding. The soils are deficient of most of the plant nutrients, have very low organic matter contents and minimum moisture holding capacity, especially in the northern and middle region chars (SRDI, 2001). Bangladesh has acquired 5471 square kilometres of new land until 2010 since independence in riverine areas (Hasan et al., 2013). This has been a blessing for the small country where agricultural land is less than 14 decimals/capita (Ministry of Land, 2015) and it is shrinking every year at an alarming rate of 0.005 ha/capita/year since 1989 (Hossain and Bari, 1996). The total charland area in Rangpur, Kurigram, Gaibandha and Lalmonirhat districts are 77895 hectares and among them about 79% are cultivable (DAE, 2016), but unfortunately those are mostly underutilized or used for low-value crops production. In general, the agricultural productivity in charland is less due to low fertility, river bank erosion, poverty, less intervention of modern agricultural technologies/varieties and also minimal services from government and NGOs. The farmers are also getting less product price due to non-diversified and low-value crops, improper marketing channel, middle man, inefficient transportation system etc. Therefore, addressing the above situation, utilization of vast northern charland for increased high-value crops production, income generation and livelihood improvement would be possible by generating and adopting appropriate technologies/approaches including promotion of business, and these are the aspiration of the project.

Progress: Co-ordinated research activities were carried out under three components i.e. Component-1: Coordination component, OFRD, BARI, Gazipur; Component-2: OFRD, BARI, Rangpur & Gaibandha; Component-3: Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh. Under OFRD, BARI, the project activities were implemented in the three char locations from northern districts i.e. Char Begumganj, Ulipur of Kurigram district; Char Jagatber of Lalmonirhat district and Char Chandanpat and Nalsia of Saghata, Gaibandha district, where laboratory of Department of Crop Botany, BAU was used under BAU part.

A baseline survey was undertaken at three char areas namely Jagatber under Lalmonirhat Sadar Upazila of Lalmonirhat; Begumganj under Ulipur Upazila of Kurigram and Chandanpat under Saghata Upazila of Gaibandha district to know the socio-economic status and to explore the existing agricultural practices for further improvement. Data were collected during July to September 2018. The results of base line survey revealed that majority of the sample farmers cultivated local variety of different crops with applying indiscriminate doses of fertilizer. Most of the farmers engaged only in subsistence farming with low agricultural productivity. In the three char areas, T. Aman rice, groundnut, chilli, grass pea, black gram, sweet potato, potato, sugarcane and Jute are the main cultivated crops. In the Kharif-II season, most of the lands are occupied with T. Aman rice or sometimes land is completely remaining fallow due to flood. So, T. Aman is a chance crop in the char land area. Sometimes T. Aman harvesting is delayed due to late planting. Rabi season is the main cultivating season of char farmers and after harvesting rabi crops, most of the farmers produce jute. Lack of knowledge about new crop variety/technology was identified as the main problem of the farmer and it was due to less intervention of modern agricultural technologies/varieties from government and NGOs. The farmers are also getting less product price due to non-diversified and low-value crops, improper marketing channel, middleman, inefficient transportation system etc.

Based on survey data, 10 (ten) different crops were selected and trials on those crops were conducted to assess the suitability of BARI released high yielding crop varieties/technologies for the char lands. All improved varieties were compared with locally adapted cultivars/varieties. The execution of the trials was initiated in September 2018 and completed by May 2019. The total monitored crop land area (three char lands) of the project site were about 7.28 ha and, in each location, it was maintained about 2.41 ha. A total of 90 trial farmers were involved for the selected field trials in the first year. Among the trialed crops, all improved varieties/technologies performed better over the local varieties/practices. Considering the crop performance, local market demand and farmers preferences, three improved varieties/technologies were selected for each location. Groundnut (var. BARI Chinabadam-9), Onion (var. BARI Pijaj-1) and Bitter gourd (var. Ucche with improved crop management practices) were selected for pilot production in Begumganj, Kurigram; Sweet gourd (var. BARI Hybrid Mistikumra-1), Groundnut (var. BARI Chinabadam-9) and Chilli (var. BARI Morich-3) were selected for pilot production in Jagatber, Lalmonirhat; where Sweet potato (var. BARI Misti Alu-8), Chilli (var. BARI Morich-3) and Foxtail millet (BARI Kaon-2) were selected for pilot production in Char Chinirpotol and Char Chandanpat, Gaibandha. During 2019-20, these selected crops were piloted in the farmers' field of Charland with the coverage of more than 2 hectares of each crop. Besides of these, farmers' producer group formation, collection point improvement, LSP development, quality improvement activities of the product, market information collection, channel development etc. were continued for livelihood improvement of the char farmers. The following table showed the yield comparison of crops grown in the chars during 2019-20.



Pilot production program of foxtail millet at Gaibandha

Considering the crop performance, local market demand and farmers preferences, three improved varieties/technologies were selected for each location. Groundnut (var. BARI Chinabadam-9), Onion (var. BARI Pijaj-1) and Bitter gourd (var. Ucche with improved crop management practices) were selected for pilot production in Begumganj, Kurigram; Sweet gourd (var. BARI Hybrid Mistikumra-1), Groundnut (var. BARI Chinabadam-9) and Chilli (var. BARI Morich-3) were selected for pilot production in Jagatber, Lalmonirhat; where Sweet potato (var. BARI Misti Alu-8), Chilli (var. BARI Morich-3) and Foxtail millet (BARI Kaon-2) were selected for pilot production in Char Chinirpotol and Char Chandanpat, Gaibandha. During 2019-20, these selected crops were piloted in the farmers' field of Charland with the coverage of more than 2 hectares of each crop. Besides of these, farmers' producer group formation, collection point improvement, LSP development, quality improvement activities of the product, market information collection, channel development etc. were continued for livelihood improvement of the char farmers. The following table showed the yield comparison of crops grown in the chars during 2019-20.

Table 3.12: Yield of crops taken under pilot production program in 2019-20

Name of crop	Yield of crop (t/ha)		
	Research plot	Farmer plot	% Increase
Ground nut	2.37	1.32	44
Sweet gourd	35.9	25.4	29
Bitter gourd	4.15	2.85	31
Onion	10.85	5.97	45
Chili	9.18	7.57	18
Sweet potato	31.5	23.4	26
Blackgram	1.35	0.85	37
Foxtail millet	2.24	1.52	32

22. Project Title: Integrated farming research and development for livelihood improvement in the plain land eco-system (ID 061)

Coordinator : Member Director (P&E), BARC, Farmgate, Dhaka

Implementing organization : BARI, BRRI, BFRI

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

Duration : Feb 2018- Jun 2021

Budget : Tk: 37000000/-

Background: The study area comprises Active Tista Flood Plain (AEZ 2- medium high land 72%: Rangpur); Karatoya- Bangali Flood Plain (AEZ 4- high land 23%, medium high land 44%, medium low land 14%: Pabna); Active Brahmaputra and Jamuna Flood Plain(AEZ 7- medium high land 37%, medium low land 20%: Tangail); Young Brahmaputra and Jamuna Flood Plain(AEZ 8- high land 18%, medium high land 42%, medium low land 19%: Sherpur) and Madhupur Tract (AEZ 28- high land 56%, medium high land 18%) and Gazipur. Major crops grown in these areas are rice, wheat, maize, jute, pulses and oil seed. Under irrigated situation major cropping pattern are Boro- T. Aman, Mustard-Boro T. Aman; Wheat-Jute-T.Aman, Maize- Mungbean-T. Aman, Potato- Boro- T. Aman etc. BARI and BRRI have already developed improved cropping pattern with management practices involving 3 or 4 crops. Besides, BFRI and BLRI also developed improved technologies on calf rearing, poultry rearing and high value fish culture. Verification of new technologies, integration of different farming components for livelihood improvement and dissemination of proven technologies developed by NARS institutes on crops, cropping pattern, climate resilient options, resource conservation technologies, plantation crops, homestead production systems, fish, livestock and poultry production as well as other income generating activities will be included in this sub-project under plain land ecosystem. This sub-project has been coordinating by Planning & Evaluation Division of BARC in partnership with On-Farm Research Division (OFRD) of the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur and Bangladesh Fisheries Research Institute (BFRI), Mymensingh from Feb 2018 .

Progress: Two cropping system experiment with three or four crop have been conducted every FSRD site. One cycle of cropping system experiment was completed. Second cycle of cropping pattern is going on. In livestock component vaccination, vitamin supplementation, beef fattening, cow, goat, sheep, chicken, duck and pigeon rearing with improve breed and management practices under farmer's condition is going on. In fishery component polyculture of carp fishes, Gift tilapia and mixed culture of Singh, Tilapia, Pabda and Golsha culture is going on in seasonal and perennial ponds at different locations. Different off farm activities like Katha stich, pickle, fried rice and embroidery has been implementing by woman which increasing their family income. It is anticipated that the project have demonstrated and established effective ways of maximizing farm productivity through dissemination and adoption of farming systems technologies with efficient used of farm resources.

BARI component: The integrated farming programs were started from February 2018 at 5 Farming Systems Research and Development (FSRD) Sites viz., Ajoddhapur (Rangpur), Gangarampur (Pabna), Sholakundu (Faridpur), Atia, Delduar (Tangail) & Tarakandi (Sherpur). The activities persistently continued during February 2019-January 2020. A total of forty five types of activities were done for maximizing the total productivity using the existing resources of sixty farmers, where twelve from each location comprising of four from each of marginal, small and medium farmers group considering homestead vegetables & fruits, field crops, poultry & livestock, fisheries and off-farm component. All components were brought under improved technological intervention and accordingly incomes were increased from these components. Integrated farming consists of several enterprises like home gardening, crops and cropping, dairying, poultry, fishery, etc. and these enterprises are interrelated. Different locations and components-wise findings are discussed below.

Homestead production system: Different models for vegetables production in homestead area in different FSRD sites under plain land ecosystem were followed Syedpur model (Ajoddhapur, Rangpur), Goyeshpur model (Gangarampur, Pabna), IshanGopalpur model (Sholakundu, Faridpur), Palima model (Atia, Tangial) and Narekeli model (Tarakandi, Sherpur).



On farm ftial at Faridpur

Vegetable production: Across different FSRD sites, the average vegetable production was maximum (310 kg homestead-1) in Rabi season followed by Kharif-2 (202 kg homestead-1) and Kharif-1 (175 kg homestead-1) seasons. Round the year total vegetable produced maximum at Pabna (845 kg homestead-1) followed by Faridpur (831 kg homestead-1) and minimum at Sherpur (408 kg homestead-1).

Fruit production: Maximum fruits were produced during Kharif-1 season (294 kg/homestead) followed by Kharif-2 season (183 kg/homestead) and Rabi season (98 kg homestead-1). However, round the year total fruits produced maximum at Pabna (1145 kg/homestead) and minimum at Sherpur (105 kg/homestead).

Crops and cropping: Two improved cropping T. Aman (Binadhan-17)-Mustard (BARI Sarisha-14)-Boro (BRRIdhan28) and T. Aus (BRRIdhan48)-T. Aman (Binadhan-17)-Potato (BARI Alu-8)/Sweet gourd (BARI Hybrid Mistikumra-1) tested against existing cropping pattern T. Aman (Swarna)-Fallow-Boro (BRRIdhan28) and T. Aman (BRRIdhan39)- Mustard (Tori-7)-Boro (BRRIdhan28) at



Mustard (BARI Sharisha 14)

FSRD site, Ajodhpur, Rangpur during 2019-20. The Rice Equivalent Yield (REY) of first improved cropping pattern was 15.74(t/ha) and second was 40.68(t/ha) which was 171% and 204% higher than existing cropping pattern.

On-farm verifications: Trials on modern varieties Mustard (BARI Sarisha-14 and 17), Tomato (BARI Tomato-15), Lentil (BARI Masur-8), Wheat (BARI Gom-28), Mungbean (BARI Mung-6), Sesame (BARI Til-4), Barley (BARI Barley-6 and 7), Okra (Shakti- Hybrid) and Potato (BARI Alu-25,35, 36, 37, 40, 41) were conducted in 2019-20 in 05 ha land with 50 farmers at five FSRD sites. Yield of new varieties was around 20-25% higher than farmers used variety.

Livestock development: Deworming was done in about 77, 35, 183 and 200 numbers of cattle during the program in Pabna, Rangpur, Tangail and Faridpur, respectively. The numbers of different types of vaccinated livestock were as 77, 122, 183, 100 and 122 in Pabna, Rangpur, Tangail and Faridpur, respectively. Maximum body weight gain (175 g/day/animal), milk production (2.55 L/day) and lactation period (215 day) was obtained from deworming and vitamin ADE injection treated cattle followed by dewormed cattle at FSRD site, Tangail, Rangpur and Pabna. Dewormed and vaccinated cattle responded positively under cattle fattening program at FSRD site, Rangpur and Pabna. Three to eight months old aged six calves were considered under calf rearing program with improved management at FSRD site, Gangarampur, Pabna. The initial average body weight was 74 kg/calf after three month of rearing average weight 122kg/calf and body weight gained 49kg/calf.



Deworming at Rangpur

Five different vaccines (BCRDV, RDV, FOWL POX, FOWL CHOLERA and Duck Plague) were used in poultry vaccination program that reduced mortality rate 73%, 77%, 86%, 100% and 80% at FSRD site, Rangpur, Pabna, Tangail, Faridpur and Sherpur, respectively. Under poultry rearing program 120 Sonali chicken were distributed among 12 farmers/FSRD site of Pabna, Tangail and Faridpur (each farmer received 09hen + 01cock). The estimated gross margin was from per household were Tk. 7500, Tk.10349 and Tk. 1050 after six month of rearing at Pabna, Tangail and Faridpur respectively. The farming system program also distributed duck (10/household) in interested farmers in Tangail and Sherpur. It also distributed Turkey 12/household and total 144 in Rangpur site. The program distributed pigeon (2pair/household) and total 24 pairs in Rangpur and 14 pair (7 pairs/household) in Pabna. In addition FSR also promoted production of farm yard manure and Pabna and green fodder in Rangpur.



Turkey rearing at Rangpur

Fisheries development: Four to twelve seasonal ponds were selected for polyculture of carp fishes at different FSRD sites. The average pond size was 0.04-0.06 ha and with 1.2 to 2 m depth over the locations. The results revealed that, in polyculture of carp fishes, the survival rate of various fishes ranged from 64% to 91%. Maximum production observed in Sherpur (296 kg/pond) with the gross margin Tk 20886/pond and minimum yield (105kg/pond) in Rangpur.



Fish harvest in Rangpur

Off farm: Among the different FSRD sites, off farm activities were supported only in Ajoddhapur, Rangpur, Gangarampur, Pabna and Tarakandi, Sherpur. The average gross margin increased 106%, with the average gross margin of Tk. 5882.

BRRRI component: Rice Farming Systems Division of Bangladesh Rice Research Institute has been studying farming system research and development at Sreepur, and Gazipur from February 2018 till date. Total 18 activities were undertaken and continued during last two years (Feb 2018 to Jan 2020) under homestead production system, crops and cropping system, livestock production system, and fisheries production system, fruit sapling distribution, fruit tree management in the homestead.

Homestead production systems: BARI developed Goyeshpur model was followed in homestead production systems with 12 farmers. The land area of 12 farmers under vegetables and fruit production in the homestead was 87 decimal. Total productions of vegetables during reporting period was 2417 kg. Among the produced vegetables 1147 kg, 1012 kg and 243 kg were sold, consumed and distributed respectively. Total cost of production was Tk 20,700/- and gross return from homestead vegetables production was Tk 60,050/-. Consumption, distribution and selling of vegetables increased about 10%, 43% and 134% respectively in the second year.



Off farm activity at Sherpur



Year round vegetable production

Crops and cropping: The improved cropping pattern was Mustard-Boro-T. Aman and Mustard-Mungbean-T. Aus-T. Aman. From the economic analysis it was observed that the highest gross margin 61300 Tk/ha was obtained from Mustard-Mungbean-T. Aus-T. Aman. The gross margin from Mustard-Boro-T. Aman was 48100 Tk/ha. The Mustard-Mungbean-T. Aus-T. Aman and Mustard-Boro-T. Aman gave about 350% and 253% higher GM compare to the existing pattern Boro-Fallow-T. Aman.

Livestock development: Pigeon and goat rearing increased farm income. Turkey farming is more profitable than poultry farming as it takes less space and less risk of diseases. Seventy turkey chickens were distributed among 7 farmers at the FSRD site, Sreepur, Gazipur during September 2018. After 16 months of rearing average body weight was 7.5 kg. The market value of the birds after 16 months rearing was about Tk 24,000/- and total cost was about Tk 14,000/-. These results indicated that turkey production is profitable.

Fisheries development: Pabda (Ompok pabda) and gulsha (Mystus cavasius) many important indigenous fish are greatly threatened and a few such as pabda (Ompok pabda) and gulsha (Mystus cavasius) are on the verge of extinction. These species generally grow in natural water body. These two types of fishes are favorite to consumers because of its delicious taste but high price in the market. These two types of fishes have been cultivated in the farmers pond at FSRD site following recommendation of BFRI. It will be harvested very soon.

Other activities included drumstick plantation, utilization of fallow land under orchard, spraying of fruit trees is in progress. Fruit sapling distribution, chewing type sugarcane cultivation at homestead, Palmyra seed sowing, management of mango trees etc. were also done. About 150 seeds of palmyra palm tree were sown at different places in Tengra village of Telihati union on October 7, 2018. After sowing about 94% of them are survived.



Palmyra plantation

BFRI component: Culture of Pabda & Gulsha with carp in farmer's pond to evaluate the production performances of pabda (*Ompok pabda*) and Gulsha (*Mystus cavasius*) with carp in pond during June to November 2019 for the period of 6 months. In the polyculture system Pabda, Gulsha, Rui and Silver Carp were cultured in the pond. Average net bent 1736245t/ha was found after six month of rearing. The fish farmer would get opportunity to sell the high valued fish Pabda and Gulsha at a higher price in the market and they would also get an opportunity to consume the fish. Culture of Monosex GIFT (*Oreochromis niloticus*) with Shing (*Heteropneustes fossilis*) and Magur (*Clarias batrachus*) in farmer's pond for the period of four month. Average area of the pond was 0.25 acre. After six months of rearing the average production was 12913kg/ha. The better production was obtained where the contribution of Shing and Magur were 10.50%. The net profit was 490352Tk/ha. Shing (*H. fossilis*) were cultured with other species which contributed to increase the total production as well as net income.



Harvested gift tilapia

Other activities included homestead vegetable gardening, integrated rice fish culture, poultry and duck rearing

23. Project Title: Design and development of fertilizer deep placement mechanism for existing rice transplanter (ID 064)

Coordinator : Director (Admn and CS), BRRI, Joydebpur, Gazipur

Implementing organization : Farm Machinery and Postharvest Technology (FMPHT) Division and Soil Science Divisions of BRRI, Joydebpur, Gazipur

General objective : To incorporate fertilizer deep placement (FDP) technology in the existing walking and riding type rice transplanter for simultaneous application of fertilizer mixture with rice seedlings transplanting

Duration : Jan 2018–Dec 2020

Budget : Tk: 1,10,00000/-

Background: Manual transplanting is tedious and time consuming which often the causes of delayed planting. As a result, mechanized rice transplanting is seen as a solution of labour problems. Likewise, using mechanized rice transplanting ensures uniform plant spacing (both the line to line and plant to plant) as well as fast and efficient planting. It has potentiality and gaining popularity in Bangladesh due to intervention of different private and government programs. BRRI believes that there is good scope for adoption of transplanter in Bangladesh. Incorporation of the fertilizer mixture (Urea, TSP, MoP and Gypsum) deep placement (FDP) technology with the existing mechanical rice transplanter (both the walking and riding type) will help to accelerate the adoption of both the technologies to the end users.

The farmers of Bangladesh normally apply the urea fertilizer as prilled formed by hand broadcasting method. The prilled formed a smaller and softer substance than other materials commonly used infertilizer blends. As a result, major portion of urea fertilizer losses in different ways after top application to the field while deep placement of urea (either granule or prilled form) in transplanted rice is an agronomically efficient and environmentally safe as compared with the traditional application method of prilled urea. Based on this concept, BRRI has been developed a push type prilled urea applicator. It was found suitable during field trials in different soil conditions and seasons though laborious to operate manually. In addition, farmers need additional one machine for fertilizer application. This is also not suitable for other basal fertilizer (TSP, MoP and Gypsum). Hence, an attempt has been under taken to incorporate the fertilizer deep placement technology (suitable for either urea alone or combination of urea, TSP, MoP and Gypsum together) to the existing mechanical rice transplanter (both the walking and riding) without sacrificing the merit of transplanting to ensure both the mechanized rice transplanting and fertilizer deep placement simultaneously.

Progress: Mixed fertilizer deep placement mechanism was incorporated in the walking (ARP-4UM) and riding type (S3-680) rice transplanter. Both the technology improved based on problems identified during field trials in Boro 2019-20 season. In both type rice transplanters, spiral type mechanism was improved based on field trials. In Boro 2019-2020 season, the developed walking type rice transplanter was evaluated in 07 different locations of the country. RCB design was followed in both the seasons with three replications. Treatments of the studies were mechanical transplanting along with mixed fertilizer deep placement simultaneously (T1), mechanical transplanting and hand broadcasting of fertilizer (T2) and traditional transplanting and hand broadcasting of fertilizer (T3). Total data were tabulated and analysis is under process. In Aman 2020 season, a total of 06 validation trails were set up in the project locations (Netrakona, Kumarkhali, Mirpur, Rangpur and Gazipur). Field performance data is under process. During trails, farmers showed their interest on the developed technology for its multifunctional use of the machine. In addition, two experiments on mat type seedling raising were conducted with the help of two MS level students of Sylhet Agricultural University, Sylhet.

A total of 07 field evaluation trials of walking type rice transplanter cum mixed fertilizer applicator were conducted in Boro/2019-20 season at the farmers' field of Kushtia, Mirpur, Rangpur, Netrakona, Habiganj and Gazipur. All data including machine and crop performance were tabulated and analysis is under process.

Table 3.13: Locations, variety, dates of seeding, transplanting and harvesting; and planting area of the trials

Sl. no.	Locations	Variety	Date of seeding	Date of transplanting	Date of harvesting	Area of transplanting (Decimal)
1	Khumarkhali-1, Khustia	BRRi dhan89	7/1/2020	9/2/2020	31/05/2020	400
2	Khumarkhali-2, Khustia	BRRi dhan28	7/1/2020	10/2/2020	16/05/2020	400
3	Mirpur, Khustia	BRRi dhan89	7/1/2020	8/2/2020	29/05/2020	110
4	Rangpur	BRRi dhan58	11/1/2020	15/02/2020	28/05/2020	120
5	Netrakona	BRRi dhan89	30/12/2019	1/2/2020	26/05/2020	125
6	Habiganj	BRRi dhan58	10/01/2020	18/02/2020	14/05/2020	65
7	Gazipur	BRRi dhan89	27-12-2019	28-01-2020	23/05/2020	65

A total of 06 field evaluation trials of walking type rice transplanter cum mixed fertilizer applicator were set-up in Aman/2020 season at the farmers' field of Kushtia, Mirpur, Rangpur, Netrakona, Habiganj and Gazipur. Crop condition is good and machine performance data is under process.

Table 3.14: Locations, variety, dates of seeding, transplanting and harvesting; and planting area of the trials

Sl. no.	Locations	Variety	Date of seeding	Date of transplanting	Date of harvesting	Area (decimal) transplanted
1	Khumarkhali-1, Khustia	BRRi dhan87	4/08/2020	29/08/2020	-	400
2	Khumarkhali-2, Khustia	BRRi dhan87	4/08/2020	30/08/2020	-	400
3	Mirpur, Khustia	BRRi dhan87	11/08/2020	31/08/2020	-	120
4	Rangpur	BRRi dhan80	29/07/2020	16/08/2020	-	65
5	Netrakona	BRRi dhan87	03/07/2020	05-08/08/2020	-	600
6	Habiganj	BRRi dhan80	29/07/2020	18/08/2020	-	65
7	Gazipur	BRRi dhan80	28/07/2020	13/08/2020	-	65

24. Project Title: Economic viability and production efficiency of rice: A macro level study in Bangladesh (ID 070)

Coordinator	: Director (Admn and CS), BRRi, Joydebpur, Gazipur
Implementing organization	: Agricultural Economics Division, BRRi, Gazipur and Department of Agricultural Economics, BAU, Mymensingh
General objective	: The study will assess the economic viability of Aus, T. Aman and Boro rice for three farm types in the different ecosystem of Bangladesh by evaluating the profitability, risks, production efficiency and constrains of rice cultivation to generate important information for different stakeholders for boosting main staple production in future
Duration	: Jan 2018 – Jun 2020
Budget	: Tk: 2,11,93,260/-

Background: Considering its dense population and climate vulnerability, Bangladesh has to face a great challenge to ensure main staple rice security for the growing population in the latter half of the century which has reached its land use in frontier level already (Ahmed et al., 1999, MoEF, 2009, WB 2013). Thus, strategic adaptation policy needs to be included with the future economic and social development planning for ensuring food security and improving well-being of the people in a sustainable manner (WB, 2013). It is also the case that farmers' decision to adopt a new technology or crops or rotations is most likely to be influenced by the level of profitability and risk associated with the respective crops or rotations (Dillon, 2003; Kabir et al 2016). Therefore, ensuring availability of information about profitability, risks, resource use efficiency and constraints of rice farming for the different ecosystems (e.g., saline coastal, drought prone, submergence, haor, char, hilly and favorable) is critically important to undertake appropriate decision about crop choice and/or land utilization/production of combination of crops. Thus, an assessment of the profitability, risks, production constraints and production efficiency of rice is grown in the different ecosystem is timely. It can be noted that the study could be generated a comprehensive set of data for the various stakeholders including policy planners for formulating the suitable policies to expedite the growth of rice production for meeting the growing demand of staple food grain of population in the future.

Progress:

BRRRI component: According to the categories of agricultural regions characterized by Department of agricultural extension (DAE), BRRRI component conducted survey in 10 regions; namely Mymensingh, Cumilla, Chattogram, Sylhet, Khulna, Jashore, Barishal, Rajshahi, Rangpur, and Dinajpur for data collection. Following the sampling framework procedure, initially 20 districts was selected from 10 regions, two from each of the region. Similarly, 40 Upazilas were selected from the selected 20 districts, 2 from each and finally, 80 villages was selected from the chosen 40 Upazillas, two from each Upazila. Thirteen Aus rice growers, thirty eight each of T. Aman and Boro rice growers were considered for interview from each village of two Upazilas of each district. Data were collected from total 2700 farmers (40% of BRRRI) from aforementioned five regions was collected. Data collection and data entry of the collected data are going in full swing. Procurement of computer accessories, furniture and electronic equipment (photocopier, camera, GPS and projector) had already been completed. Selected and trained data enumerators continue conducting field survey to collect data from the farmers in study regions. During second year of the project, data collection was seriously hampered due to covid-19 pandemic. Till reporting period the major achievement of the project is illustrated in the following table.

Table 3.15: Major outputs and remarks

Sl. No	Major technical activities performed	Achievements so far		Remarks
		BRRRI part	BAU part	
1	Development of questionnaire	100%	100%	Complete
	Pre-testing of the questionnaire	100%	100%	Complete
2	Modification of the questionnaire as per pretesting and field requirements	100%	100%	Complete
3	Recruitment of part time accountant	100%	100%	Complete
4	Recruitment of computer operator	100%	-	Complete
5	Selection and visit of the study areas	50%	100%	Partially
5	Procurement of capital items	90%	-	Partially
6	Data collection (No. of sample)	2700	2000	Partially
7	Data entry (No. of sample)	2000	2000	Partially
8	Analysis for the collected data	Partially done	Partially done	Data entry going on

Irrespective of the regions, the farmers are using more seed for rice production than the BRRRI recommendations. However, among the regions, seed rate is relatively lower in Mymensingh region. Besides employing labor on man-day basis payment, farmers are emphasizing payment on contact per activity. Farmers in the surveyed locations are employing more fertilizers than the recommendations. All the regions required supplementary irrigation in Aus and Aman seasons. The yield of Aus season is the highest in Chottagram region (5.43 ton/ha), whereas it is in Cumilla for T. Aman (5.01 ton/ha) and Boro (6.39 ton/ha) seasons. Generally, the rice yield is better in Cumilla compare to the other regions.



Farmer interview in Debbider of Cumilla

Table 3.16: Input use pattern in three different rice growing season in four study region

Items	Chottagram		Cumilla			Mymensingh			Sylhet		
	Aus	Boro	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro
Seed(kg/ha)	54	31	40	42	41	35	37	35	47	48	45
Seedbed cost (Tk/ha)	2779	2322	2370	2970	3022	2299	2327	2546	3489	3550	3467
Land preparation (Tk/ha)	8028	8459	6672	8134	8831	7410	7449	8012	8300	8300	8500
Human labour (man-days/ha):											
Family labour	24	38	24	29	12	40	47	53	26	23	25
Hired labour	42	47	48	54	59	10	33	14	46	44	43
Contract (Tk/ha)	14408	0	16753	12114	15789	10437	7115	7989	4396	3115	5796
Fertilizer (kg/ha):											
Urea	173	199	157	244	249	178	172	232	193	162	190
TSP	160	84	132	160	171	43	33	63	95	79	105
MOP	202	56	115	100	121	49	44	77	60	57	68
DAP	0	6	11	4	12	65	55	81	15	26	23
Gypsum	0	16	24	24	23	5	5	26	16	17	12
Zinc	0	2	24	13	8	0	3	4	3	4	3
Irrigation cost (Tk/ha)	4940	14268	1300	1977	13793	152	940	10400	1806	755	8612
Herbicides (Tk/ha)	0	594	4422	2863	2920	815	806	1202	850	828	1230
Insecticides (Tk/ha)	1544	2320	1830	1750	1677	1594	1490	1116	1763	1385	1758
Rent use cost (Tk/ha)	7332	7332	12600	12800	14800	13300	13600	14900	16210	22125	37161
Yield (kg/ha)	5434.0	5299.2	5336.4	5011.5	6388.9	4605.2	4972.6	5458.7	3917.6	4118.0	5832.3
Straw (Tk/ha)	12041	6059	9022	11204	8375	5674	11045	4658	3474	3708	3492

BAU component: Procurement of computer accessories had already been completed. Recruitment of PhD student was completed through proper procedures. The selection and training of data enumerator was also completed to conduct field survey for data collection from the farmers in study regions. The survey questionnaire was again modified as per field survey. Data from total 2000 farmers (70% of BAU) from three regions was collected. The input use patterns of the participated farmers are illustrated in the following table.

Table 3.17: Input use structure in Boro season in Haor of Kishoreganj

Particulars	Study areas/ Haor ecosystem	
	Cost (Tk./ha)	Percentage (%) of total cost
Variable costs (Tk./ha)		
Human labor	34496.8	48.07
Power tiller	5371.0	7.48
Seed/seedlings	4794.8	6.68
Fertilizers		
Urea	5412.3	7.54
TSP	2640.8	3.68
MoP	1629.6	2.27
DAP	963.7	1.34
Total	10646.2	14.83
Irrigation	8000.1	11.15
Insecticides & herbicides	408.2	0.57
i. Total Variable cost (Tk./ha)	63717.3	88.78
Fixed costs (Tk./ha)		
Land use cost	4865	6.78
Interest on operating capital	3185	4.44
ii. Total fixed costs (Tk./ha)	8050	11.22
iii. Total costs (Tk./ha)	71767.3	100

25. Project Title: Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based agroforestry system to mitigate the climate change (ID 072)

Coordinator : Member Director (NRM), Forest Unit, BARC, Farmgate, Dhaka

Implementing organization : SAU (Sylhet Agricultural University), and BTRI (Bangladesh Tea Research Institute), Sreemangal, Moulvibazar-3210

General objective : Sustainable production of tea through the integration of climate resilient tea and shade trees in tea based agroforestry system

Duration : Jan 2018 – Jun 2021

Budget : Tk 2,38,000,00/-

Background: The annual production/ha of tea in Bangladesh is 1275 kg, which is lower than India (1668 kg), Kenya (2321 kg) and Sri Lanka (1763 kg). It is assumed that by 2025 the domestic requirement of tea would be about 84.06 million kg (461g per capita) against the production of 73.63 million kg (Ahmed, 2012). Tea production is decreasing in the country due to age-old tea estates and lack of modern production technologies, while domestic consumption is gradually increasing (Ahmed, 2012). So far BTRI has developed 18 clone varieties but the adaptation of new varieties/cultivars has not yet been satisfactory. Appropriate measures are to be taken to promote HYV tea cultivation to increase tea production. Moreover, traditional forest trees (*Albizia* spp.) are now being used as shade trees in tea estates/gardens. So, economically important fruit and timber trees especially Moringa, Jujube, Acacia, Koroi (*Albizia lebbek*),

Neem (*Azadirachta indica*), Black pepper and Yam and some climbing plant species, eg., betel leaves need to be evaluated to select new alternative climate resilient shade trees for tea estates/gardens. The research activities of the sub-project has been conducted at SAU, Sylhet and BTRI, Sreemangal, Moulvibazar & Panchagarh district in coordination with Natural Resource Management Division, Bangladesh Agricultural Research Council (BARC). The LoA has been signed on 28 December 2017 and will be completed in June 2021.

Progress: The research activities of the sub-project are being conducted at Sylhet Agricultural University (SAU), Sylhet and Bangladesh Tea Research Institute (BTRI), Sreemangal, Moulvibazar in coordination with Natural Resources Management Division, Bangladesh Agricultural Research Council (BARC). The goal of the sub-project is sustainable production of tea through the integration of climate resilient tea and shade trees in teabased agroforestry system. Achieving the goal, details activities of 1st year were presented in the progress review workshop on 23 June 2019 at BARC in presence of experts' panel. Twenty-two tea estates in Sylhet region were surveyed. The average area of 22 tea estates was 715 ha with an average yield of 1581 kg ha⁻¹. Five shade tree species are used as the permanent shade and three species are used as temporary shade. Four shade tree species are often used as the wind breaker plant species in the roadside and outside of the estates. Insects and mites are common tea pests. Different groups of insecticides and miticides are used successfully against these pests. Selective and nonselective herbicides, i.e. Paraquat and glyphosates are used to control weeds in the tea estates. Tea Germplasm Center and a Tea Nursery have been established at SAU campus. Morphological parameters viz., numbers of branch and leaf, main stem diameter and plant height of 21 BT clones and 9 TV clones have been measured. Besides, morphological parameters viz., leaf length, pedicel length, internodal length, leaf vein, leaf serration, pedicel to first serration, leaf breadth and leaf angle have been measured. One submersible pump has been installed for irrigation in dry season. Survival rates of Chui jhal (*Piper chaba*), Black pepper (*Piper nigrum*) and Moringa (*Moringa oleifera* Lam.) in Clonal Tea estate, Sreemangal, Moulvibazar; Burjan and Khadim Tea estates, Khadimnagar, Sylhet have been determined. A training program was held under the sub-project where General Managers, Managers and Assistant Managers of 23 tea estates of Sylhet, Moulvibazar and Habiganj districts were participated. Besides, 2 BTRI scientists and some teachers of Crop Botany & Tea Production Technology and Entomology departments, Faculty of Agriculture, SAU were participated in the training. One PhD student of the sub-project, two MS students and one undergraduate student were also participated in the training. Germplasm were collected from 16 tea estates of Moulvibazar, Sylhet and Bandarban (a new selection region of Chittagong). A total of 150 plants were preliminary selected from these tea estates and top six germplasm was also selected on the basis of yield, quality and flavory performance. Collected cuttings raised in the nurseries at BTRI main station in order to screening them at nursery conditions. A new germplasm center was established and 100 new germplasm from different tea estates were planted for conservation. To evaluate suitable shade tree species for tea based agroforestry models three experiments were also established at three different locations namely: (1) Bilashcherra Experimental Farm, BTRI, (2) Monipur tea estate, Fenchugonj, and (3) Huq tea estate, Panchagarh & Rahman Small Tea Grower, Panchagarh.



Saplings of BT20

26. Project Title: Exploration, identification, characterization, multiplication and ex-situ conservation of endangered forest genetic resources including medicinal plants of Bangladesh(074)

Coordinator	: Member Director (NRM), Forest Unit, BARC, Farmgate, Dhaka
Implementing organization	: BAU, BFRI, University of Chittagong
General objective	: Collection, identification and characterization of forest genetic resource and medicinal plants of Bangladesh and Documentation of the status, scope and Ex-situ conservation of the selected Forest Genetic Resources (FGR) including ethno-medicinal plant in Bangladesh
Duration	: Jun 2018 – June 2021
Budget	: Tk. 2,71,61,506/-

Background: Forest Genetic Resources(FGR) refers to the heritable materials maintained within and among tree and other woody plant species that are of actual or potential economic, environmental, scientific or societal value. Conserving forest genetic resources (FGR) is vital for a nation, as they are unique and irreplaceable resources for the future. Trees are the dominant structural element in forests and several other terrestrial ecosystems (agroforestry, woodlands and gardens), intercepting much of the radiant sunlight, dominating photosynthetic processes and carbon flows, and comprising a large proportion of the biomass. The biodiversity of the forest, however, has been heavily degraded during last few decades due to rapid population growth, energy deficit, over exploitation, poor management and lack of motivation on the needs of biodiversity conservation. One of the essential elements of the convention on biological diversity (CBD) is a commitment by Government to survey their natural living resources, both domesticated and wild and to conserve noted sites for their biological diversity as well as threatened species and domesticated varieties. But, identification of various important components of biodiversity through systematic and scientific approach is still inadequate in Bangladesh.

Bangladesh is an immense reservoir of medicinal plant resources. Medicinal plants constitute a very important component of plant diversity particularly the biodiversity rich areas in the Chittagong Hill Tracts (CHTs) comprises of three hill districts namely Bandarban, Rangamati and Khagrachari. CHT is the south eastern part of Bangladesh covering an area of 13,295 square kilometer with an inhabitant of 11 tribal communities. Herbal medicine has been widely and effectively used for the remedy of various diseases in the region by the tribal people over generations. Thus this valuable indigenous wealth of the plant species for medicinal values including knowledge of their uses in the CHTs to be explore, identify and measures to be taken for their conservation. The present sub-project is designed to consider the above facts and to document the selected Forest Genetic Resources (FGR) including ethno-medicinal plant in Bangladesh.

Progress: The research activities of the sub-project are being conducted at Department of Horticulture, Bangladesh Agricultural University (BAU), Mymensingh as Component-1, Minor Forest Products Division (MFPD), Bangladesh Forest Research Institute, Chottagram as Component-2, and Institute of Forestry and Environmental Sciences, University of Chottagram (IFESCU), Chottagram as Component-3, in coordination with Forest Unit, Natural Resources Management Division, Bangladesh Agricultural Research Council. The goal of the sub-project is to enrichment of bio-diversity through conservation and utilization of Forest Genetic

Resources (FGR) especially medicinal plants in Bangladesh. To achieve the above goal, details activities with expected outputs and outcomes were presented in the workshop held on 02 September 2019 at the training building of BARC, where the participating organizations presented their plan of activities. Officials of BARC and sub-project personnel are constantly monitoring and evaluating the activities of the sub projects through the desk monitoring and/or the reports from the participating organizations. Study was done by the Component-1 (BAU) at Natore, Tangail (Modhupur) and



Plus tree of M. longifolia

Sherpur districts where local people/villagers/healers/practitioner, were interviewed about the plants they used for the management of their common ailments. Field survey was done for identifying the status of threatened tree species in these areas. Saplings/seeds/seedlings of 50 different medicinal plants species were collected and 800 seedlings/saplings planted at BAU-GPC for characterization and conservation. Morphological characterization of 30 medicinal plants was done. Multiplication of Terminalia chebula, Terminalia bellirica, Withania somnifera, Codariocalyx motorius, Ocimum tenuiflorum, Cissus quadrangularis, Vitex negundo, Terminalia arjuna, Bryophyllum pinnatum, Gynura procumbens, Aloe vera is started. A demonstration plot has been established at Natore with 36 different species of medicinal plants.

Field survey was carried out by the Component-2 (BFRI) in five selected 'Upazilas' of Chittagong Hill Tracts Viz., Rowangchari, Gagra, Kaptai, Kutukchari, and Matiranga. Five groups discussion conducted with local Boiddayas and they were interviewed individually for the use of ethno-medicinal plants. Two hundred ethno-medicinal plants have been collected and documented along with their locality, local name, habit, habitat and other related information. Herbarium sheet of all the plants prepared and preserved as a voucher specimen. As a part of germplasm conservation seedlings, rhizomes and cuttings of 55 medicinal plant species have been collected, grown and maintained in the raring center at MFPD nursery of BFRI, Chottagram. Prepared a priority list of medicinal plants according to the desire of herbal healers and raised 4000 seedlings for distribution among them.

Field survey was done by the Component-3 (IFESCU) in the natural remnant forests of Chattogram, Cox's Bazar, and Tangail for identification the status of threatened tree species in these forests. Fruit/seed of 22 selected tree species were collected from Hazarikhil Wildlife Sanctuary and Kalurghat Forest Depot of Chottagram, Barshijura Seed Orchard Centre of Moulavi Bazar, Ukhiya Seed Orchard Center of Cox's Bazar and Madhupur National Park of Tangail and recording phenological characteristics. Standardization of propagation techniques and characterization of fruit/seed biology of 22 selected tree species have been completed. Establishment of Conservation Stands of 40 different tree species has also been done

27. Project Title: Upliftment of farmers livelihood and enrichment of environment through improved agroforestry practices in char land ecosystem of Bangladesh (077)

Coordinator : Member Director (NRM), Forest Unit, BARC, Farmgate, Dhaka

Implementing organization : Department of Agroforestry, BAU; BARI, Jamalpur, Department of Agricultural Economics, BAU, Mymensingh

General objective	: Poverty alleviation of the people of char area and environment enrichment through agroforestry
Duration	: Jan 2018 – Jun 2021
Budget	: Tk2,90,103,56/-

Background: The charland people generally use their indigenous knowledge to adapt at the diverse environment. These communities are most vulnerable; least served, and chronically marginalized which require a different approach by the service providers like government, NGOS, etc. So, it is important to improve the indigenous knowledge of forestry/agroforestry with modern practices to adapt with the char environment. The important elements of agroforestry systems can play a significant role in the improvement of livelihoodsthrough changes in homesteads and croplands. The anticipated activities of agroforestry practices could increase the biodiversity and reduce the temperature fluctuation in the selected charland as well. The research activities of the sub-project on “Upliftment of farmers livelihood and enrichment of environment through improved agroforestry practices in char land ecosystem of Bangladesh” is being conducted at Department of Agroforestry, Bangladesh Agricultural University (BAU), Mymensingh; Regional Agricultural Research Station (RARS) Jamalpur, Bangladesh Agricultural Research Institute (BARI) and Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh in coordination with Forest Unit, Bangladesh Agricultural Research Council (BARC). The goal of the project is to uplift farmers’ livelihood and enrichment of environment through modern agroforestry practices in the char areas of Bangladesh.

Progress: Monitoring activities of the participating organizations are being conducted maintaining through different meetings, workshops, spot visits, e-mail correspondence, telephonic conversation, receiving different reports, etc., by the Coordination Component of BARC.

BAU-AF component: Winter vegetables/crops cultivation as agroforestry practice with sajna (Hybrid) tree in charland ecosystem also showed not significant yield reduction with sajna (Hybrid) spalings. But in association with eight years old lombu tree yield of sweet gourd and bitter gourd severely affected where 85-90% yield reduction was recorded compare to without lombu tree combination. From this results it is clear that during the early stage of fruit and medicinal tree species winter vegetables/crops can be cultivated without significant yield loss but in association with wide canopy coverage lombu tree yield of winter vegetables/crops severely affected. 5000 seedlings of different timber and fruit tree species were distributed among the selected 30 (thirty) farmers of four different char villages of sub-project research areas of which 1225 mango, 950 mahogany, 300 dwarf narikel, 850 malta (BARI Malta-1), 725 akasmoni, 250 lemon and 700 lombu tree sapling. During summer season four summer vegetables viz; Stem amaranth (BARI Danta-1), jute (D-154-2) as leafy vegetables, kangkong (BARI Gimakolmi-1) and Indian spinach (BARI Puishak- 1) were practiced with 1.5 years old different medicinal, timber and fruit tree species. The effect of these tree species viz. sajna (Hybrid), mango (BARI Aam-4), malta (BARI Malta -1), guava (BARI Peara- 2), aonla (BARI Amloki- 1), horitoki (Local) and bohera (local) on studied summer vegetables i.e. Stem amaranth (BARI Danta -1), jute (D-154-2) as leafy vegetables, kangkong (BARI Gimakolmi-1) and indian spinach (BARI Puishak -1) was significant. Results from different experiments conducted in summer season of 2019 indicated that very near the base of all tree species yield of all summer vegetables had remarkably reduced (25-30%). The experiment which is being conducted under lombu tree following multi-storied agroforestry practice is not complete yet, the observed results will be presented after completing the experiment in the coming report. During winter season different winter vegetables viz; radish as leafy vegetable (Local), radish as root crops (BARI Mula- 1),

carrot (Royal cross), turnip (White Flat), spinach (Capi pala), red amaranth (BARI Lal shak -1) and mustard as leafy vegetable (BARI Sarisha- 9) were practiced with 2 years old different medicinal, timber and fruit tree species. The effect of these tree species viz. mango, malta (BARI Malta-1), guava, mahogany, lombu, horitoki, aonla and bohera on studied winter vegetables i.e. radish as leafy vegetable, carrot (Royal cross), radish as root crop (BARI Mula- 1), turnip (White Flat), spinach (Capi pala), red amaranth (BARI Lalshak- 1) and mustard as leafy vegetable (BARI Sarisha- 9) were significant. Results from different experiments recorded in winter season of 2019, it was found that very near the base of all tree species yield all winter vegetables was remarkably reduced (40-45%). Existing average C:N ratio of different research plots of this sub-project was 9.77 : 1.

BARI-Jamalpur component: Six different experiments were conducted at three different locations (Nao Vangar char, Jamalpur Sadar, Bolaier char, Sherpur Sadar and Regional Agricultural Research Station, BARI, Jamalpur) during the winter season of 2018-2019 to evaluate the performance of radish, sweet gourd and mustard (leafy vegetables) under timber tree species based agroforestry practices and fruit tree species based agroforestry practices to increase the production of vegetables by using the fallow land under timber and fruit garden as well as to increase the income of the farmers in char areas of Jamalpur and Sherpur. In 1st three completed experiment (Timber tree based agroforestry practices) three different vegetables, viz., radish (Long White Mino), sweet gourd (Bengal Sweet-2) and mustard (Tori 7) were cultivated with three different timber trees, viz., eucalyptus, mahogany, and akashmoni tree during the establishment of plantation. It was found that radish performed better than other vegetables. In 4th, 5th and 6th completed experiments (Fruit tree based agroforestry practices) three different vegetables, viz., radish (Long White Mino), sweet gourd (Bengal Sweet-2) and mustard (Tori 7) were cultivated in association with three different fruit tree species, viz., mango, guava, and lemon plant during the establishment of plantation. Results of the completed experiments also indicated that radish performed better than other vegetables. In kharif season, six different experiments (Timber tree based agroforestry practices and fruit tree based agroforestry practices) were conducted at Nao Vangar char, Jamalpur Sadar, Bolaier char, Sherpur Sadar and Regional Agricultural Research Station, BARI, Jamalpur. But one experiment was destroyed due to water logging condition. In 1st two completed experiment (Timber tree based agroforestry practices) four different vegetables, viz., Indian spinach (BARI Puishak-1), sweet gourd (Bengal Sweet-2), okra (BARI Derosh-2)and yard long bean (BARI Borboti-1) were cultivated with two different timber tree species viz, akashmoni and eucalyptus tree during the establishment of plantation. It was found that sweet gourd performed better than other vegetables. In 3rd, 4th, and 5th completed experiment (Fruit tree based agroforestry practices) four different vegetables, viz., Indian spinach (BARI Puishak-1), sweet gourd (Bengal Sweet-2), okra (BARI Derosh-2) and yard long bean (BARI Borboti-1) were cultivated in association with three different fruit tree species, viz, mango, guava, and lemon tree during the establishment of plantation. From these experiments were also found that sweet gourd performed better than other vegetables. Four different experiments were conducted at Nao Vangar char, Jamalpur Sadar and Regional Agricultural Research Station, Jamalpur in year round. Experiments of Nao Vangar char were affected due to flood. These experiments were not completed. In this year total 2000 seedlings/saplings were distributed to the selected farmers of Jamalpur sadar and Sherpur sadar area.

BAU-Socio-economic component: A total of 240 farm households were counted for the baseline survey of the project. A multistage random sample technique was applied to select the sample. The results showed that most of the farmers in the study areas are either young (20-30 years) or experienced farmer

(above 50 years old) and they are mostly illiterate. In Mymensingh, most of the sample farmers are male (94%) whereas in Jamalpur and Sherpur the percentage of male farmers is 89% and 74%, respectively. Agriculture is the main source of employment for the people of the study area and most of the farmers are small according to their farm size. Main crops grown in the study areas include jute, wheat, potato, onion, and various types of vegetables. Majority of the farmers in the study are not familiar with agroforestry practices. The farmers who adopted agroforestry practices either got support from the Bangladesh Agricultural University, Mymensingh or from the Bangladesh Agricultural Research Institute (Jamalpur). They practice agroforestry mainly to sell wood or fruits. The tree species include Akashi, Eucalyptus, Mehogoni, Mango, Jackfruit, Guava, Lemon, and Coconut. Farmers showed their interest to adopt agroforestry practices though some farmers mentioned some problems such as lack of government support, lack of training, lack of technical knowledge and skills, lack of information, etc., in practicing agroforestry. The present livelihood status of charland farmers was assessed through investigating their physical, human, social, natural, and financial capital. Agroforestry can be a promising agricultural practice for the char land people of Bangladesh, which can eventually improve their livelihood.

28. Project Title: Eco-friendly rodent management through owl conservation (087)

Coordinator : Director (Admin & Common Services) current charge, BRRI, Gazipur-1701

Implementing organization : BARI, BRRI

General objective : Sustainable rat management through owl conservation

Duration : Feb 2018 – June 2021

Budget : Tk. 1,73,17,575/-

Background: Rodents are major agricultural pest in Bangladesh for crop production, both before and after harvest. Estimated loss in Bangladesh is about Tk. 1360 million per year (field and store) with average loss of rice 53 kg/farm family/year. The rat damaged crops amounting 1% of the total crops produced in a year. Owls (pecha) are nocturnal birds of prey. The barn owl (*Tyto alba*, family Tytonidae, order Strigiformes) is the most widely distributed species of owl. It is found almost everywhere in Bangladesh and considered as the bio-control agents of rats. Rice and wheat field rats have a large territory. A rat may move up to 200 meters in one night. In contrast, barn owls serve important function in the natural ecosystem over a large area for rat control. Natural rat control using barn owls can reduce the use of rodenticides and their indiscriminate use that can be retained as negative effects on the environment. Utilization of natural predators like barn owl is an environment friendly solution to pest control (Singleton 1994; Johnson et. al., 1996). In May 2012, it was revealed that farmers in Israel and Jordan had, over a period of ten years, replaced rodenticides by barn owls in a joint conservation venture called "Project Barn Owl" (Santorelli, 2012). The Malaysian Department of Agriculture has successfully implemented a program to control rats using barn owls in paddy fields throughout Peninsula Malaysia (Hafidzi et. al., 1999). Therefore, barn owl has been found to be a very effective biological agent for controlling rats. Its use not only increases farmers' income by reducing crop losses, but also saves the cost of rodenticides as well as the fields from chemical pollution.

Progress:

National Agricultural Technology Program: Phasse-2 (NATP2) aimed to increase agricultural productivity through enhancing agricultural technology generation under Agricultural Innovation Fund (AIF-1). For this, a project entitled "Eco-friendly Rodent Management through Owl Conservation" was approved by the assigned

committee of PIU-BARC. The main objective of the project is sustainable management of rat through owl conservation. The project activities were implemented in Cumilla, Gazipur (for both, BRRRI & BARI) and in Rajshahi districts with the following specific objectives- i) To study the bio-ecology of available owl species and their mass rearing techniques, ii) To develop and validate the effective rat management technique(s) using owl in rice and wheat ecosystem, and iii) To upscale the developed techniques and buildup public awareness on owl conservation for sustainable rat management.



Barn owl, collected from BRRRI, Gazipur

Entomology division of BRRRI and Vertebrate Pest Division (VPD) of BARI are implementing the research activities for sustainable rat management. BRRRI component conducted the research activities in rice based ecosystem at BRRRI, Gazipur and in BRRRI R/S, Cumilla whereas, BARI component in wheat and vegetables based ecosystem in BARI, Gazipur and FRC and BWMRI in Rajshahi districts. Each component has executed more or less same activities in different locations to achieve the aforesaid objectives with the challenge as of both the owl and rats are wild, nocturnal and active at night period.

BRRRI component: Three species of owl, two from Roumari, Kurigram and rest one from project sites were collected and brought to the owl aviary to identify at species level with the reference sources. These species are rearing in Entomology Division, BRRRI and will be characterized at their adult stages. In addition, BRRRI developed four different types of eco-friendly rat management (EFRM) techniques / devices, which have been tested and fine tuned in BRRRI farm, Gazipur to catch and kill the rice field rats in rice based eco-system. The rat capture devices, used in rice field bunds or close to the bund of burrow systems were very effective. Around 44 watching towers (WT) were placed in different plots in BRRRI, Gazipur and in BRRRI R/S, Cumilla to facilitate owls for their preying at night. Cone shaped nylon net was used with the WT to collect the regurgitated pellets. Owl regurgitated the previous prey item as “pellet” before preying new one. Three meter height is suitable for preying. Owl WTs are effective from dusk to dawn. Around the WT, newly developed burrows become inactive and reduced in number by 10 -15% around 50 dia meter areas. Pellets collected from the watching towers were analyzed carefully and showed that most of the pellets consist of rat bones, skins, exo- skeleton of insects. The observed pellets confirmed the rat predation (Rat skeleton found in regurgitate pellet). So, WTs would also be used as perching devices during day time for insect feeding birds, black drongo (*Dicurus adsimilis*). Among the five different types of owl nest boxes, triangular shape nest box is more preferable than others for owl nesting.



Asiatic owl found in kurigram

BARI component: Thirty watch towers were set in Gazipur and 20 watch towers were set in Rajshahi. Fifteen owl nest boxes were also placed in different trees in Gazipur and 12 nest boxes were placed in Rajshahi. The diet of the barn owl, *Tyto alba* and the spotted owl, *Athene brama* were studied in the habitat of Gazipur and

Rajshahi district. Regurgitated pellets of these two owl species were analysed to understand their dietary composition. The diet of the barn owl mainly comprised small mammals (75.07%) and insect while the diet of the spotted owl comprised mostly insects (57.7%) and Mus spp (21.61%). The barn owl and spotted owl consumed more than one prey per day and consumed both small mammals and insects of agricultural importance under crop ecosystems. So, the diet of the barn owl mainly comprised small mammals and insect while the diet of the spotted owl comprised mostly insects and Mus spp. The presence of only mice among different rodent species found in the diet of spotted owl and small mammals are dominant in the diet of barn owl indicates that they have potential in regulating rat and mouse population's in crop fields as one of the components in integrated rodent pest management options. Studies may, however, be taken to attract them to the crop fields by installing artificial nest boxes, X-shaped perches or poles with nest boxes.



Placement of owl nest box

Collection, identification and documentation of different owls, study on their biology, ecology and food preference, breeding capacity as well as their behavior to mate or offspring are fully depend on the establishment of good quality owl aviary. These experiments will be conducted after the establishment of the owl aviary and rat breeding ground at Entomology Division, BRRI. For this, the fund has been revised and approved. Establishment of owl aviary is very important for the successful application of this sub-project. The tendering activities are under process. However, this project has significant role in food safety of Bangladesh and aligned with SDG goal 2. That's why; policy level support is needed for smooth and long-term activities of this unique subject.

29. Project Title: Establishment of profitable cropping pattern through crop intensification in underutilized unfavorable ecosystem (089)

Coordinator	: CSO, Plant Breeding Division, BINA, Mymensingh-2202
Implementing organization	: Adaptive Research and Extension Division, BINA; Agricultural Economics Division, BINA
General objective	: Increasing cropping intensity through introducing improved cropping patterns for improving the farmers' livelihood
Duration	: May 2018 – June 2021
Budget	: Tk. 1,60,00,000/-

Background: Present cropping intensity of Bangladesh is 194% (BBS 2017) which is the average of 23.55 lakh ha of one cropped 38.47 lakh ha of two cropped and 17.11 lakh ha of three cropped area. The share of land areas for pulse and oilseed in this cropping intensity are 8.53 lakh ha and 8.86 lakh ha only; and the productions are 377 and 933 tons which meet 20% and 30% of country's demand, respectively. Increase of cropping intensity is the only way to boost up pulses and oilseed production. By incorporating short duration pulse and oilseed varieties in rice based cropping sequence, cropping intensity is possible to increase from 194 to 400%. Cultivation of traditional varieties, imbalance use of fertilizers, seed sowing inappropriate time, -adoption of modern production technologies, natural calamities, socio-economic barrier, large yield gap (

20-60%), nutrient mining in existing cropping pattern, unavailability of seeds of suitable HYV varieties, drought, flash flood and other biotic and abiotic stresses are the main constraints of maximizing farm productivity. On the other hand, according to the 7th Five Year Plan and SDGs, poverty alleviation, end hunger, achieve food security and improved nutrition and promote sustainable agriculture are the new challenge for researchers, extensionists and farmers. BINA and BRRI developed short duration T. Aman and Aus rice varieties that mature within 90-120 days and producing grain yield of 5-6 t/ha, which created opportunity of crop intensification. BINA and BARI already developed pulses and oilseeds varieties with high yield and less crop duration that could be fitted in the cropping sequence of the area of underutilized and unfavorable ecosystems. Based on above facts, some areas like Sunamganj, Rangpur, Gopalganj, Nalitabari (Sherpur) and Mymensingh are considered for establishing alternative profitable cropping pattern(s). Proposed activities of adaptation trials, farmers motivation to adopt improved technologies, their knowledge & skill development and up-scaling using suitable varieties and proper time of sowing/transplanting technique based on integrated nutrient management, identification of suitable area for mustard, lentil, grass pea, sesame etc. cultivation to address the constraints above rice, oilseeds, pulses and other crops cultivation following appropriate technologies in proper time will maximize the farm productivity and profitability by reducing yield gap and improving cropping pattern in the above areas having unfavorable and underutilized ecosystem. The sub-project is being executed by Adaptive Research and Extension Division of BINA in collaboration with four sub-stations and Agricultural Economics Division since Jul 2018. Char Gaghra, Mymensingh.

Progress: In this year (2019-20), economic profitability related data were analyzed from the experimental site at Char Ghagra, Mymensingh Sadar. Best crop wise variety combination in the pattern was determined based on total rice equivalent yield (REY) and benefit cost ratio (BCR) at this location. But in other locations, it was determined based on total REY only. All the six proposed patterns comfortably accommodated an additional crop in between T. aman and Boro/Aus rice at all five locations of Bangladesh with BINA released crop varieties. But at Mymensingh Sadar Upazila, two additional crops were accommodated after T. aman. For early T. aman rice - Mustard - late Boro rice cropping pattern, the crop wise



Late boro rice variety Binadhan-14 at Rangpur

variety combination BRRI dhan71- Mustard (Dugi)- Binadhan-14 ranked top followed by Binadhan-11-Dugi-Binadhan-14 and Binadhan-7-Dugi-Binadhan-14 based on total REY and benefit cost ratio (BCR). But total duration (TD) taken by the first crop wise variety combination was the longest followed by the second and third combinations. Exactly the same trend was found for the other pattern at this location with four crops, early T. aman rice - Mustard – Patshak - Aus rice, i.e., the crop wise variety combination BRRI dhan71- Mustard (Dugi) – Patshak – Binadhan19 ranked top followed by Binadhan11 – Dugi – Patshak-Binadhan19 and Binadhan7 – Dugi – Patshak -Binadhan19 for total REY, BCR and TD. But at Sherpur, Binadhan17 - BARI Sharisa14-BRRI dhan58 ranked top based on total REY although TD of this combination was 28 days more than the combination that includes Binadhan14. The final conclusion will be drawn based on the BCR which will be calculated later.

At Muktarpara, Rangpur, for (i) early T.aman rice - Mustard - late Boro rice pattern, the crop wise variety combination Binadhan17- Binasarisha9- Binadhan14 ranked top. For (ii) early T. Aman rice - Potato - late Boro rice pattern, Binadhan17 – Asterix - Binadhan14 had the highest total REY.

At Bishwambharpur Upazilla of Sunamganj, for (i) early T. aman rice - Mustard - late Boro rice cropping pattern, Binadhan17-BARI Sharisha16- Binadhan14 was the best and at Sunamganj Sadar for (ii) early T. aman-Grass pea-Aus rice pattern, Binadhan17- Binakhesari1- BRRi dhan48 ranked top followed by Binadhan17- Binakheshari1- Binadhan19 but the former combination took 19 days more time than the latter apart from the fact that Binadhan19 was inundated by flood water for 3-4 days at panicle initiation stage that hampered pollination.



Binasarisha-9 field at Kashiani, Gopalganj

At Kashiani, Gopalganj, for (i) early T. Aman rice - Mustard - Jute pattern, jute is not harvested yet; for (ii) early T.

Aman rice - Grass pea - Aus rice pattern, Binadhan17- Binakhesari1- Binadhan19 ranked top and for (iii) early T. Aman – Lentil- Aus rice pattern, Binadhan17- Binamasur8-Binadhan19 ranked the top.

30. Project Title: Identification of novel resistant gene(s), gene pyramiding and sustainable management of bacterial blight (BB) disease of rice (ID 091)

Coordinator : Director (Admin & Common Services), BRRi, Gazipur-1701

Implementing organization : BRRi, BAU

General objective : To manage bacterial blight disease through gene pyramiding and biological approaches

Duration : Jan 2018 - Dec 2020

Budget : Tk. 15438152/-

Background: Rice plant infected by 32 diseases of which ten are major and three bacterial diseases are frequently occurred in Bangladesh. Among them, Bacterial blight considered as most destructive disease occurs in all AEZs. The disease may reduce 30-60% rice yield and observed as chief factor limiting rice productivity worldwide because of its high epidemic potential (Khan et al. 2014, Verdier et al. 2012, Xia et al. 2012). Increased application of nitrogen fertilizer in rice encourages the occurrence and the severity of this disease. The disease is also influenced by some climatic factors such as rainfall, humidity, temperature, flood and stormy weather during the rice-growing season (Soga 1918, Fujikawa et al. 1957 and Mizukami and Wakimoto 1969). Heavy rain, high humidity and temperature provide the favorable conditions for high incidence and the severity of the disease (OCTA 1970). In this study, novel or known BB resistant gene(s) will be identified from native germplasm and implement the successful use of near isogenic lines along with molecular markers to identify races and its' distribution as well as to introgress minimum three bacterial blight resistance genes into the popular rice varieties BRRi dhan63. BRRi dhan81 or BRRi dhan49 having high yield potential through marker-assisted backcrossing. Simultaneously, environment friendly and sustainable management package will be developed against BB of rice.

Progress: Total 581 germplasm was collected from BRRi gene Bank and 481 germplasms were screened against 3 virulent isolates of bacterial blight. Among the germplasms, 14 entries were trend to resistant while other entries showed moderately resistant reaction to highly susceptible reaction. A total of 60 resistant rice

germplasms (Derived from resistant screening) were reconfirmed through gene base SSR markers and pathogenicity test against bacterial blight (*Xanthomonas oryzae* pv. *oryzae*) pathogen in T. Aman 2019. Five (5) specific SSR markers were used for confirmation of Xa4, xa5, xa13, Xa21 and Xa23 gene among the germplasm. Out of 60 germplasm (according to molecular data), Two (3) germplasm (Acc. No.: 4216 & 7370) contain 3 resistant genes (Xa4, xa5 and xa13/Xa21), 22 germplasm contain 2 resistant genes (Xa4 and xa5/x13/Xa21) and others have single or no resistant gene. For the identification of bacterial blight races, 400 samples were collected from different regions of Bangladesh. From the collected samples, 350 *Xanthomonas oryzae* pv. *oryzae* isolates were isolated, purified and preserved. Disease reaction patterns were recorded on near isogenic lines by inoculating 350 *Xanthomonas oryzae* pv. *oryzae* isolates at maximum tillering stage during Boro 2018-19 and T. Aman, 2019 to identify new physiological races of bacterial blight across the country. A total of 12 bacterial blight races were identified from 350 *X. oryzae* pv. *oryzae* isolates. For the development of bacterial blight resistant variety, in total 670 seeds of advance generation (BC2F1, BC3F1) were obtained from the crosses between BRRIdhan81, BRRIdhan81-Pi9, BRRIdhan63-Pb1, BRRIdhan49 and IRBB60, IRBB58, IR129336:11-4.



Stracing of bacteria in PSA medium

In BAU component, in boro season 2019, the efficacies of formulated fungal and bacterial antagonists identified in boro season 2018 were evaluated in two hybrids viz. Hybrid Hera 2 and ArizeTej Gold and two inbred viz. BRRIdhan 28 and BRRIdhan 29 rice varieties under both net house and field condition. The results revealed that the effect of two formulated *Trichoderma* spp. such as *Trichoderma paraviridescens* and *Trichoderma erinaceum* were observed significant in reducing lesion length caused by *X. oryzae* pv. *oryzae* in all four varieties.



View of Net house experiment

At 28 days after inoculation (DAI) under net house condition, considering all four varieties the maximum (4.80 cm) lesion length was recorded in untreated plants. However, these two formulated fungal bioagents viz. T2 = *T. paraviridescens* and T3 = *T. erinaceum* reduced lesion length by 52.94 and 45.26%, respectively as compared to control. The effect of eight different formulated bacterial spp. viz. T2 = *Pseudomonas putida*, T3 = *Pseudomonas putida*, T4 = *Pseudomonas taiwanensis*, T5 = *Pseudomonas* sp., T6 = *Pseudomonas plecoglossicida*, T7 = *Pseudomonas putida*, T8 = *Pseudomonas* sp] and T9 = *Pseudomonas fluorescens* were observed significant in reducing lesion length in all the varieties tested under both net house and field condition. At 28 DAI under net house condition, all the formulated bacterial bioagents reduced lesion length by 48.38 to 62.20% which are slightly higher or almost similar to T1 (55.29%). However, at 28 DAI under field condition, considering all four varieties the maximum (3.13cm) lesion length was recorded in untreated plants (control). All the formulated bacterial bioagents reduced lesion length by 47.95 to 50.03% which are almost similar to T1 (45.93%). The formulated bacterial antagonists showed an increase of yield in all the four varieties by 13.58 to 29.94% as compared to control.

In boro season 2019, two fungal isolates were identified by dual culture method that inhibited around 25% growth of *X. oryzae* pv. *oryzae*. These two fungal isolates were identified as *T. asperellum* by homology search of the sequences of ITS region using Blast program. In the same growing season, a total of 14 bacterial isolates were identified by dual culture method that inhibited the growth of *X. oryzae* pv. *Oryzae* by 20.83 to 60.86 %. These bacterial isolates were identified by homology search of the sequences of 16S rDNA using blast program. In aman season 2019, the efficacies of formulated fungal and bacterial antagonists identified in aman season 2018 were evaluated in one hybrid viz. Dhanigold and three inbred viz. BRRIdhan 49, BINAdhan 7 and BINAdhan 11 rice varieties under both net house and field condition. The effect of eight different formulated bacterial spp. were observed significant. Under net house condition at 28 DAI, these bacterial bioagents reduced lesions length by 31.65 to 33.93%. Under field condition at 28 DAI, all these formulated bacterial bioagents reduced lesions length by 47.72 to 48.65%. The formulated bacterial antagonists showed an increase of yield in all the four varieties by 17.26 to 23.15% as compared to control. In aman season 2019, a total of 14 bacterial isolates were identified by dual culture method that inhibited the growth of *X. oryzae* pv. *oryzae* by 50.93 to 61.54 %.

All the financial activities were carried out properly during the reporting period. Progress of procurement was satisfactory as per procurement plan. BRR component spent 92.9% and BAU component spent 93.1% of the released budget. No severe problem encountered in the reporting period.

31. Project Title: Improvement of farm productivity through intervention with Improved agricultural technologies in char land eco-system (ID-096)

Coordinator : Member Director (P&E), BARC, Farmgate, Dhaka

Implementing organization : BARI, BINA, BSRI, BLRI

General objective : To increase farm productivity of char land area intervening whole farm activities

Duration : Feb 2018 - Jun 2021

Budget : Tk: 37000000/-

Background: Char dwellers inhabit under extremely marginal environments out of necessity, moving from one char to another in the face of river and island erosion. Access to markets and wage employment is limited, whilst agricultural work is especially scarce during unpredictable floods and the period between planting and harvesting of rice. Still large number of people stay in the chars taking high risk of natural vulnerability. According to the 7th Five Year Plans and SDGs, poverty alleviation, end hunger, achieve food security and improved nutrition and promote sustainable agriculture is the new challenge for researchers, extensionists and farmers. Considering the complex factors the char dwellers often could not choose the best farming practices to be followed in their lands. As a result their income becomes lower. From the activities of some projects and NGOs it is clearly understood that, integrated farming approach is one of the best way for income generation of char dwellers. But this integrated farming system approach may play a vital role to overcome the above mentioned situation in charland eco-system. The project has been coordinated by Planning & Evaluation Division of BARC in partnership with On-Farm Research Division (OFRD) of the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, Bangladesh Rice Research Institute (BRRI),

Joydebpur, Gazipur; and Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh from February 2018.

Progress: Char areas of Bangladesh are also a hub of hydro meteorological disasters like unpredictable flash flood, seasonal drought, soil erosion and so on. To keep the above issues in the mind, the project activities were identified and prioritized to maximize the farm productivity and farmers benefits with efficient use of farmer's existing resources. The activities of the project were initiated from early February 2018 at different FSRD sites of the following components

BARI component: The farming systems researches of charland ecosystems of the component are being conducted at FSRD sites of Charkharicha, Mymensingh and FSRD Site, Charpara, Sonatala, Bogura. The following farming systems models are tested during the reported period.

Homestead production system: After intervention the vegetable production was increased by 100% as earlier no vegetable were produced in their homesteads. The total vegetable production in the homestead was 1312kg/homestead/year. The average vegetable intake, distribution and sold per farm family were 696 kg, 85 kg and 631 kg respectively. The gross return from vegetables per farm was recorded as Tk. 19673 with the gross margin of Tk 18593 from which Tk 9466 could be benefitted as cash income per family per year.

Year round vegetable production: Goyeshpur model at homestead area was carried out Bogura during February 2019 to January 2020 with 12 farm families. The total vegetable production was 521kg/homestead. The model increased vegetable production by 344% and the average vegetable intake/year/5 member family was 349.16 kg (increased by 344%) against 78.65 kg per/year/family earlier. The gross return from vegetables per farm was Tk. 5211 with the gross margin of Tk 4059.



Vegetable production at FSRD site

Management of fruit trees: Quick growing fruit trees like papaya, lemon, banana along with other existing fruit trees mango, jackfruit, coconut, wood apple were managed through pruning, pest control, fertilization and irrigation. The management intervention increased fruit production by 190% and it helped higher fruit intake/family/year (60.3 kg from 20.77 kg before intervention).

Crops and cropping system: Two improved cropping pattern Mustard (BARI Sarisha-14) - Boro (BRRI dhan28) - T. aman (Binadhan-11) rice and Potato (BARI Alu-25) - Boro (BRRI dhan28)-T. aman (Hybrid; Dhani gold) tested against existing cropping pattern Fallow- Boro (BRRI dhan28) - T. aman (BRRI dhan49) rice and Fallow - Boro (BRRI dhan28) -T. aman (Hybrid; Dhani gold) at the FSRD site, Mymensingh during 2019-2020. The higher total gross margin Tk. 238670/ha and BCR 1.56 was obtained from improved cropping pattern Mustard (BARI Sarisha-14) - Boro (BRRI dhan28) - T. aman (Binadhan-11) rice. The higher total gross margin Tk. 283800/ha was obtained from



Mustard (BARI Sarisha - 14)

improved cropping pattern Potato (BARI Alu-25) - Boro (BRRI dhan28)-T. aman (Hybrid; Dhani gold). A four crop based cropping pattern Mustard (BARI Sarisha-14)-Boro (BRRI dhan28) -T. aus (BRRI dhan48)-T. Aman (BRRI dhan52) was also successfully established in Mymensingh site.

On-farm verification trials: Under the program the trials of newly released varieties, technologies and management practices of snake gourd, bottle gourd, bitter melon, amaranth, potato, mustard, sweet potato, wheat, maize etc. were set in the FSRD sites. In almost all the cases the new varieties showed their production superiority over the existing ones. Farmer's responses were highly positive towards the varieties. BARI were demonstrated in farmers' field. It was observed that potato, sweet potato, mustard, wheat and maize produced 26.0, 65.0, 1.47, 24.52, 3.62 and 7.50 t/ha respectively.

Livestock development: The vaccine group Anthrax, FMD, BQ and HS were vaccinated the cattle and a good number of poultry birds were vaccinated with BCRDV, RDV, Fowl pox, cholera and Duck plague as per recommended schedule both the site of FSRD during 2019-2020. A total of 400 cattle at FSRD site, Mymensingh including buffalo, cow, ox and calf were vaccinated under this program and vaccination were done on anthrax and FMD of cattle. After the vaccination frequency of different diseases was reduced and it was found that vaccination could reduce 87% disease incidence of cattle. Four types of poultry vaccines:



Duck rearing at Bogura site

BCRDV, RDV, Fowl Pox, Fowl Cholera and Duck plague were vaccinated in the program. After vaccination of poultry, all of the diseases frequency reduced drastically and mortality rate is about 5%. Other activities included deworming of cattle, poultry and duck rearing and a total number of 110 cattle were dewormed. The body weight gained by dewormed milking cow was 40 g/day/cow whose average lactation yield was increased up to 0.4 L/day over the control. Duck rearing was another intervention practiced in both the FSRD sites. In each site 12 farm households were selected for duck rearing and 8 khaki cambel duck given per family. Two farmers, each was provided with single ewe for rearing at the project site of Bogura. The animals were vaccinated and provided with feed. Both the adult ewe gave birth to new offspring. One ewe gave 3 kids and another one gave 2 offspring. Overall, the net present value is Tk. 23000.

Fisheries development: Under the project, carp polyculture and mono sex tilapia culture in seasonal or perennial ponds was undertaken. Mono sex tilapia was cultured in FSRD site, Mymensingh whereas mixed polyculture with carp was followed in FSRD site, Bogura during 2019-2020. Three seasonal ponds were selected for mono sex tilapia fish's culture in FSRD site, Mymensingh during 2019-2020. The average size of the ponds was 20 decimal. After four month the results revealed that, average production was 120kg and income was 14240Tk/ from 25 decimal of pond. The BCR found from mono sex tilapia culture was 3.73.



Mixed polyculture at Bogura site

BINA component: Two villages were selected from the FSRD sites Naowvanger Char, Sadar Upazila, Jamalpur district for carrying out project activities from February 18 till date. Total 12 cooperator farm families, four from each category of marginal, small, and medium were selected for intervening farming systems technologies. Total 10 activities were undertaken during February 2019 to January 2020. The research activities were homestead production system, crops and cropping system, livestock production system, sapling distribution and fruit tree management in the homestead.

Homestead production system: BARI developed Goyeshpur model was followed for year round vegetables production with land area of 35 decimal per farmer. During Kharif-I season vegetables like bottle gourd, sponge gourd, snake gourd, bitter gourd, yard long bean, summer tomato, indian spinach and okra, in kharif-II season bottle gourd, country bean, cucumber, Indian spinach and red amaranth and in Rabi season country bean, bottle gourd, chili, tomato, cauliflower, cabbage, radish and brinjal were grown during reporting period. During reporting period average vegetable production was 6518 kg among which they consumed 1135 kg, distributed 617 kg and sold 4766 kg. The gross income of each farmer from vegetables production was 85,069 Tk. Total fruit production was 347 kg among which they consumed 232 kg, distributed 68 kg and sold 47 kg.



Sponge gourd at trellis

Crops and cropping system: Improvement of three cropping pattern were under taken to increase system productivity: (i) Jute (JRO 524)-T. Aman (Binadhan-11)-Mustard (Binasarisha-9), (ii) Jute (JRO 524)-T. Aman (Binadhan-11) - Wheat (BARI Goam - 26) and (iii) Jute (JRO 524) -T. Aman (Binadhan-11) - Maize (hybrid 981) against farmers existing pattern Jute – T.Aman – Grass pea (fodder) First cycle of cropping pattern Jute (JRO 524) -T. Aman (Binadhan-11) - Maize (hybrid 981) against farmers existing pattern Jute – T.Aman – Grass pea (Fodder) was completed. Gross margin increased 140% in improved cropping pattern than existing cropping pattern. The trials repeated in the second year also and observed similar results.

Livestock development: At the FSRD site 150 cattle were vaccinated and dewormed. The dewormed cattle produce more milk (1.6 L/day) than non-dewormed cattle (1.0 L/day). Average body weight was increased in dewormed cattle than non-dewormed cattle. Before vaccination mortality rate was 5% which became zero after vaccination. The study supported beef fattening program that increased average body weight of the cattle by 51% at the first round and 52% at the second round. Each farmer on an average sold it by Tk. 97,000 and 65,000 at first and second round respectively. Average profit per farmer was calculated Tk. 77,000. Ten selected farmers



Beef fattening program

were given 40 pairs of pigeon (four pair/farmer) to increase the farmers' income and nutrition of the project farmers. Average two pairs of pigeon were consumed by the farmer during reporting period. Each farmer were given 15 chickens at first and second batch and 20 chickens at third batch. After 75 days of rearing body weight of the chicken increased to 1280 to 1332 gm/chicken from 200-230 gm/chicken initial weight.

Sapling of fruit trees were distributed among the farmers and during the reporting period 30 litchi saplings (China-3) along with 30 bay leaf and 40 hogplum saplings were distributed among the farmers. The survivability rate of fruit sapling was 92% and it was growing stage during reporting period. From two years result it can be concluded that due to implementation of farming system technology, increases farmer's income, nutrition uptake as well as improved livelihood improvement of cooperator farmers.

BSRI component: The farming system research and development activities under this project were implemented by 12 selected farmers in the two villages at FSRD site Saraghat and Pakshi, Ishurdi Pabna. Intervention of farming systems research and development activities started from early February 2018. Fifteen research and develop activities were undertaken from homestead production system, crops and cropping system, livestock system, fisheries system, agro forestry and off farm activities during 2019-20.

Homestead production system: During Kharif-1 season, stem amaranth, brinjal, lady's finger, yard long bean, white gourd and sweet gourd, while in kharif-II season indian spinach, red amaranth, stem amaranth, bitter gourd, white gourd and bottle gourd and in the Rabi season radish, cabbage, tomato, and bottle gourd were grown at the homestead of selected farmers. Before intervention vegetables production per household was only 37 kg which was found 4740 kg after intervention. The gross income of each farmer from vegetables production was T. 63,055. Fruits production were increased remarkably in homestead area due to improved management of fruit tree through pruning, pest control, fertilization and irrigation in quick growing fruit trees (guava, papaya, lemon, ber, banana etc.) along with other existing fruit trees (mango, litchi, jackfruit and coconut etc.).



Vegetable production at fench in Kh season

Management of fruit trees and chewing type sugarcane:

A total of 192 saplings of different fruits were distributed among 12 farm households. The saplings were litchi (bombay), mango, dragon fruit, malta, lemon, sapota and guava. Chewing type sugarcane variety Rongbilash were planted at 12 selected farm homestead of FSRD site ishurdi, Pabna during 2019-2020. The program was under taken for increase nutrition status as well as income of farm family. It was found that each farm family earned Tk.3450 during reporting period.

Crops and cropping: The experiment was under taken to replace the existing traditional sugarcane varieties by high yielding new varieties developed from BSRI and increased income by cultivating newly released variety. The tested varieties were Isd 34, Isd 39, Isd 40, BSRI Akh 43, BSRI Akh 44, BSRI Akh 45 and BSRI Akh 46. Seven variety of sugarcane were tested at 12 farmer's field at FSRD site during 2019-20. Cost of each plot was Tk 19,600/ha and total income was Tk 39,631 and gross marine was Tk 20,031 per farmer.



Chewing type sugarcane at homestead

Livestock development: Under the component six development activities viz improvement of cattle health by deworming, Beef fattening, Vaccination program on cattle, Pigeon rearing, Chicken rearing and Cultivation of Napier grass were carried out during 2019-2020. At the FSRD site 100 cattle's were dewormed. The dewormed cattle produce more milk (1.2 L/day) than non-dewormed cattle (1.0 L/day). Average body weight was increased in dewormed cattle than non-dewormed cattle. For fattening purposes 12 cattle from 12 farmers were selected and two round beef fattening 1st one before Eid-ul-Adha and second round at the end of the year 2019. Average body weight of the cattle was increased 52% at the first round and 53% at the second round. Under vaccination program 100 cattle were vaccinated to control major diseases. Before vaccination program mortality rate was 7% after vaccination mortality rate was seems to zero. Twelve selected farmers were given forty eight pairs of pigeon (two pair in each family). Twelve selected farmers were given 720 chicks (Each farmer 60) of which 95% chicken survived. After three months of rearing, the body weight of chicken was increased from 200-230 gm/chick to 1590 - 1950 gm/chicken. Each house hold earned Tk. 10811, Tk. 8881 and Tk. 7695 from first, second and third batches, respectively. Twelve farmers were selected for Napier grass cultivation at FSRD site. The land area of each farmer was 33 decimal. The average yield of green fodder was 52 t ha⁻¹. It was also observed that total cost of production was Tk 4,500, income, Tk 15,000 and net profit Tk 10,500 from 33 decimal of land.



Production of Napier grass in farmers' field

Fisheries component: Twelve ponds were selected from twelve cooperator farmers for carp fish polyculture. The average size of pond was 40 decimal. Six species of carp fishes eg. Rui, Katla, Mrigal, Grass carp, Silver carp and Bata were stocked in the ponds during April 2019. The average survivability rate was 86%. The fish were harvested after 9-10 months. Average fish production was found 629 kg and net income Tk. 55288 from 40 decimal pond.

Some farm families especially the women of FSRD site Ishurdi, Pabna were engaged in off-farm activities like weaving NokshiKatha, sewing cloths with machine, making different handicrafts and earned Tk. 12000/- from weaving NokshiKatha per year.



Off farm activities at FSRD site Pabna

BLRI componnet: Two villages (Jugnidhaho and Khamarsanila) of FSRD site Baghabari, under Regional Station of BLRI Shahjatpur, Sirajganj were selected for carrying out project activities. In conformity with the objectives of the study, farmers of three categories viz marginal, small and medium were selected for addressing integrated approach of the programmer. Fourteen research and development activities on homestead production system, crops and cropping system, livestock production system and fisheries production were conducted during 2019-20.

Livestock development: At the FSRD site Baghabari, Sirajganj03 farmers were selected for milk production purpose through cow rearing. Deworming and vaccination of the cattle were done regularly against major disease after intervention of program. After 5 month of intervention milk production increased on an average by 5-7%. After four month of beef fattening (rearing) the farmers sold their cattle during Eid-ul-Azha and

average net income was estimated 40000/ per cattle. Six farmers under small and marginal group were given 02 Black Bengal goat and the sheep doe (01 male 02 female) per family. Average number of goat and sheep increased 5 and 6 per farm family respectively. Nine pair of pigeon provided among 03 farmers (03 pair/family) and 72 turkeys were provided among the 12 farmers (6/family). After six months rearing average number of pigeon increased seven pair per farm family. Average income increased 1500Tk per farm family. Average weight of Turkey after five month rearing was 3.5 kg per bird. Twenty six ducks distributed among two farmers (13/family) and 300 hilly chicken were distributed among 12 farmers (25/family) at FSRD site Baghabari Sirajganj during 2019-20. Napier fodder cuttings were distributed among three co-operator farmers at FSRD site Baghabari, Sirajganj during 2019-20. Average yield was found 2.0- 2.5 t/ha from five cut. Average income per farmer was Tk.23,700 from 11 decimal land from five time harvesting.



Goat vaccination at FSRD site

Homestead vegetable, fruit and spices production:

Vegetables like red-amaranth, spinach, cabbage, cauliflower, tomato, brinjal, bottle gourd, country bean, carrot, radish, pigeon pea leaf, and coriander leaf were cultivated during Rabi season; sweet gourd, ridge gourd, snake gourd, white gourd, ladies finger, panikachu (lati), yard long bean, stem amaranth and indian spinach were grown during Kharif season in FSED site Baghabari, Sirajganj during 2019-20. Fruits (Papaya, olive, coconut, lemon, banana and guava); spices (bay leaf, black pepper, cinnamon and drumstick) were grown in the homestead. Vegetable and fruit production per participating family increased from 114kg and 69 kg to 168kg and 95 kg. Total 260 various types of fruits, seedling i.e. papaya, lemon, olive, drumstick, lotkon, Sapota, betel nut, wood apple, custard apple and malta were distributed among 12 selected farmers.



Production of winter vegetables

Crops and cropping: Two improved cropping patterns Mustard (BARI Sharisa-14) –Boro (BRRI dhan74)-T. Aman (BRRI dhan51), and Onion (BARI Piize-1) –Sesame (BARI Til-1) - T Aman (BRRI dhan51) were tested against existing Fallow-Boro (BRRI dhan29)-T. Aman rice (local), during 2019-20 at Baghabari Sirajganj. Higher Gross margin Tk 105318/ha was found from improved cropping pattern, which was 385% higher than existing pattern. Cost benefit ratio of improved cropping pattern was 1.59. Another improved cropping pattern Onion (BARI Piize-1) -Sesame (BARI Til-1) -T Aman (BRRI dhan51) produce higher Gross margin Tk 141170/ha which was 286% higher than existing pattern. Cost benefit ratio of improved roping pattern was 1.97.

Fisheries Development: Mixed poly culture of carp fishes was conducted at FSRD site Baghabari Sirajganj during 2019-2020 with one farmer. The pond size was 10 decimal. The fishes were harvested after five month of release of fingerling. Total yield of fish after five month was 85 kg/pond. Total gross margin was Tk 4284/pond and cost benefit ratio was 2.29.

32. Project Title: Livelihood improvement of farmers through integrated farming system research and development of drought and rainfed Eco-system (097)

Coordinator	: Executive Chairman, BARC, Farmgate, Dhaka
Implementing organization	: BARI and BLRI
General objective	: To develop better understanding of changing nature of drought in view of climate change, risk and vulnerability associated with drought and its impact on agriculture, food security, economy and livelihood and its potential impact in the future.
Duration	: Sep2019 - Jun 2021
Budget	: Tk: 1,75,00000/- (One crore seventy five lakh)

Background: A combination of high temperature, low and erratic annual rainfall and soil moisture deficiencies, causing drought and rainfed ecosystem, have a devastating impact on agricultural production and threaten both small scale farmers. The drought prone areas are mostly covered in north western region (high Barind tract of Rajshahi and Chapai Nawabganj and Kushtia) and rainfed area Sylhet and Bandarban district of Bangladesh. An estimated cultivated area of 5.97 million ha is affected by varying degrees of drought during rabi, pre kharif and kharif season, of which about 1.22 million ha experience severe to very severe drought mainly in the north western districts of Chapai Nawabganj, Naogaon, Rajshahi, Natore, Rangpur, Dinajpur, Joypurhat, Pabna, Bogura, Chuadanga and Kushtia. The Barind area of Rajshahi district, receives the lowest, with an average of about 1200mm rainfall. The high Barind tract (HBT) of north-west Rajshahi division is different from other parts of the country due to its undulating topography having compact and low fertile soils. Drought may reduce rice yields 45-70% under severe conditions. Yield of dry season upland crops may be reduced by 50-70%.

Chapinawabganj is also in HBT and under the AEZ-26. Boro-Aus-Blackgram is the main cropping pattern by side of the Mahananda River. The Boro-Fallow-T. Aman rice is the major cropping pattern in Barind area which covers 12% of the total arable land. Now cropping intensity in this district is about 217%. Greater Kushtia are belonging to Agro Ecological Zone (AEZ) 10, 11 and 12. In this region terminal drought occurs frequently. Majority of land type is high and medium highland and cropping intensity is about 264%. Sylhet area belongs to AEZ 20 (Surma kushiyara Floodplain) about 95-98% of the area. The region occupies the eastern part of the country where the rain starts earlier and heavier than any other region. Naikhongchari is an Upazila under Bandarban district of the Chittagong Hill Tracts region. The region is dominated by tribal people. The topography of the land is characterized by undulated hills (50%) and plain lands (50%).

In general drought not only impact on yield of standing crops; Ponds can dry up affecting fisheries resources. Animal may suffer from shortage of forage and drinking water. Tree resource also can suffer. Farm laborers may lose their job due primarily to reduction in crop productivity. Employment opportunities based on agriculture may be reduced. All of these create immense pressure on lives and livelihoods of rural people and their income. Food security mainly of the small and marginal farmers becomes a critical issue. Under these circumstances, it is important to develop robust technologies and disseminate the technologies among the stakeholder that will help to overcome the potential impact of drought sustainability. An interdisciplinary, inter institutional, coordinate results based research program is necessary to address the complex nature of drought, and its impact.

Progress: This sub-project has been coordinated by Planning & Evaluation Division of BARC in partnership with OFRD of BARI and BLRI, Savar, Dhaka. An inception workshop was arranged on 15 January, 2020 with 66 participants. From six month result it can be concluded that activities of farming system research and development have been implemented as per work plan.

BARI component: About forty research activities were initiated at five locations from 15 October 2019 which continuing till date. All components were brought under improved technological intervention and accordingly incomes have been increasing from these components. Different component wise findings are discussed below.

- The required information have been collected through preliminary survey (resource inventory) of all the households through structured schedule, exploratory survey, detailed survey with semi structured schedule, case studies, empirical observation and from some secondary sources.
- The problems of the sites have been identified through detailed survey, case studies, focal group discussion, exploratory survey, personal observations etc.
- Total 60 farm households were selected considering 12 from each site.
- For year round vegetables and fruit production 07 to 09 production niches are being utilized with 07 to 10 winter vegetables in 12 homesteads in each site following high barind, Goyespur and Golapganj model. Harvesting of vegetables is on going.
- Total 10 improved cropping patterns have been selected 02 from each site (eg. Mustard-Boro-T. Aman and Wheat-Sesame-T. Aman; Lentil-Fallow-T. Aman and Wheat-Sesame-T. Aman; Lentil-Maize-T. Aman and Mustard (long duration)-T. Aus-T. Aman; Lentil-Sesame-T. Aman and Onion/sweet gourd-T. Aman; Potato-T. Aus-T. Aman and Mustard-T. Aus-T. Aman rice for FSRD and MLT sites of OFRD, Barind, Rajshahi; and Chapainawabganj; Shympur, Rajshahi; Kushtia Sadar, Kushtia and Sylhet). Short duration as well as high yielding varieties of different crops were intervened to improve the cropping patterns. In the Rabi season some crops already have been planted and some field crops are in maturity stage.
- In livestock component vaccination for cattle and poultry has been started and continuing as per schedule. Cattle fattening is going on. Improved poultry breed (Sonali) has been distributed among the selected households.
- Depending on pond suitability and farmers choice, Tilapia as monoculture and Carp as mixed polyculture have been initiated and fingerlings has already been released some ponds.

BLRI component: The project activities have conducted in two villages (Khamar Chak Para and Chakdala) of Naikhongchari upazilla under Bandarban. Based on PRA results, 12 households (marginal, small and medium) were selected from two villages (six households from each village). A baseline survey was conducted to get details information of the selected households. The different technological interventions have provided on the basis of resources of selected household. During reporting period eight (8) program have been conducted in the project area.

Livestock development: Sheep and Goat were distributed among six households. Each farmer got 3 sheep (two female and one male) and 3 goats (two female and one male). Technical supports (vaccination against major disease, necessary treatment and feed) are being provided regularly. The rest six farmers will be get goat and Sheep at the second phase. Fodder cultivation is increasing day by day at the FSRD site. BLRI-developed HYV Napier fodder cuttings were distributed among the selected six farmers. Each farmer got 500 fodder cuttings. The fodder is now in growing stage.



Sheep distribution

Vegetable, fruit and spices production in homestead: Different vegetables (red amaranth, spinach, indian spinach, cabbage, cauliflower, tomato, radish and panikachu (lati) and fruits (papaya and lemon); spices (bay leaf and black pepper) were grown during reporting period. For mixed fruit orchard development 03 farmers were selected on the availability of suitable land. Sapling of malta, lemon, papaya, dragon fruit, mango and guava will be distributed among the farmers for mixed fruit orchard development in the month of July 2020.

Fisheries development: For year-round fish production 02 ponds from each site were selected for year round fish production. These ponds are perennial in nature and having sufficient water throughout the year. Pond preparation is going on.

Off farm activities: Off farm activities viz. sewing Nakshi kantha, prepare wooden and bamboo made handicraft have been selected for promotion among interested village households.

33. Project Title: Climate resilient farming systems research and development for the coastal ecosystem (ID 098)

Coordinator : Member Director (P&E), BARC, Farmgate, Dhaka

Implementing organization : BARI, BIRRI, BINA

General objective : Maximizing farm productivity with efficient use of farm resources

Duration : Feb 2018 - Jun 2021

Budget : Tk: 36000000/- (Three crore sixty lakh)

Background: Cropping intensity in the coastal areas is far below those achieved elsewhere in the country. 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 vegetables 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 (Islam, 2003). A vast network of river systems, beels, haors, floods and ponds provides 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. BARI, BIRRI and BINA have already developed some salt tolerant rice varieties and non-rice crops (Wheat, pulses, oilseed and vegetables) and BFRI has recommended rice-fish culture suited to the coastal area which need to be validated and disseminated to the disadvantageous areas to increase productivity and farmers' income. The sub-project has been coordinating by Planning & Evaluation Division of BARC in partnership with On-Farm Research Division (OFRD) of the Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BIRRI), and Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh from February 2018.

Progress:

BARI component: undertaken 24 research activities involving 24 farm households in two villages (12 from each village) of sites Noakhali and Patuakhali. The research areas are: i) Homestead production system ii) Improvement of Crops and cropping system iii) Fisheries production system iv) Livestock production system and v) Off farm activities.

Yearround vegetable and quick growing fruit production: Based on farmers' choice and agro-ecological suitability, the vegetables production models of 'Atkapalia Model' for Nokhali and 'Lebukhali Model' for Patuakhali are being followed. Twelve farmers were selected for year round vegetables production. Vegetables were produced in the different niches of homestead. About 533 kg vegetables were produced per home state. Each farm family were consumed 347 kg, distributed to the relatives 103 kg and sold 121 kg. Total income from homestead were Tk. 15990. During this period fruit production was 142 kg of which market value was Tk.8520. About 403 kg vegetables were produced per homestead. Ten farmers produced vermicomposting at FSRD Noakhali in ring method that was supplied earlier from the project. Vermicompost was produced within 37 to 41 days. Most of the farmers used vermicompost for vegetables production and two farmers used it for watermelon production. Average production from each ring was approximately 35 kg. Improved mango, guava, papaya, malta and others (drumstick and elephant foot) sapling were distributed among the 12 cooperative farmers of FSRD site Subarnachar, Noakhali. Each farmers received six (06) types of fruit saplings Mango (BARI Aam -11, BARI Aam-4), Malta (BARI Malta-1), Guava (BARI Peyara-4) and Drumstick (Year round, and Hybrid variety). The average number of samplings per farmer was fourteen (14).



Year round vegetable and fruit production

The study distributed 180 different type of quality fruit saplings (Mango (BARI Aam-4), Guava (BARI Peyara-2), litchi (BARI Litchi-3), Malta (BARI Malta-1), Chewing type sugarcane and dragon fruit) among the 12 cooperator farmer at FSRD site, Jamla, Dumki, Patuakhali.

Crops and cropping systems: Improved cropping pattern potato (BARI Alu-72) - mungbean (BARI Mung-6) - T.aman (BARRI dhan-49) were introduced against the existing one: Mungbean (BARI Mung-6) – Fallow - T.aman (Local). Production program on sunflower (BARI Surjamukhi-2), mungbean (BARI Mung-6) and maize (BARI Hybrid Maize-9) were conducted at FSRD site Patuakhali. Average yield of sunflower (BARI Surjamukhi-2), mungbean (BARI Mung-6) and maize (BARI Hybrid Maize-9) were obtained 1.30, 1.42 and 7.8 t/ha respectively. On-farm verification trials on different Rabi crops conducted at the FSRD site Noakhali during



BARI sunflower 2 at Patuakhali

2018-19. The average yield of Boro rice (BINA dhan10), Soybean (BARI Soyben-5), Mungbean (BARI Mung-6), Cowpea (BARI Felon-1), Grass pea (BARI Khesari-2), Sunflower (BARI Surjomuki-2) and Proso millet (BARI Cheena-1) were 4.30, 1.72, 0.83, 0.89, 0.87, 1.13 and 0.93t/ha respectively. Production program of Summer Tomato with the variety of BARI Hybrid Summer Tomato-8, BARI Hybrid Summer Tomato-10 and BARI Hybrid Summer Tomato-11 conducted at FSRD site Noakhali during 2019-20. The average yield were found from BARI Hybrid Summer Tomato-8 (24.12t/ha), BARI Hybrid Summer Tomato-10 (20.43t/ha) and BARI Hybrid Summer Tomato-11 (19.65t/ha).

Livestock development: Deworming of cattle, done before fattening of animal, showed remarkable positive effect on body weight gain and market value of animal. Chicken and duck rearing especially in semi-scavenging system in the homestead created a good impact among the farm families as a good source

of income. About two pair of pigeon, two pair of Turkey, two pair of duck, and two pair of Titir were distributed among the 12 cooperative farmers. One hundred naked neck chicks and one hundred Hill chicks were collected from BLRI, Savar during 30 November, 2019 and distributed to the 12 cooperative farmer at FSRD site Noakhali. Mortality rate was more than 90% of naked neck chicks and Hill chicks.



Poultry vaccination at FSRD site Noakhali

Vaccination program: A total of 50 cow and 12 Buffalo vaccinated with FMD and Anthrax and 30 goat vaccinated with PPR. Before the intervention, percent of mortality in the area was 20% but after intervention no mortality was recorded. A total of 40 Turkeys, 150 chicken and their chicks were vaccinated with BCRDV and RDV. Thirty eight Khaki Campbell ducks were vaccinated with DPV. After regular vaccination program mortality rate is decreased significantly. A total of 60 cow and 15 Buffalo vaccinated with FMD and Anthrax. Before the intervention, percent of mortality in the area was 10% but after intervention no mortality was recorded. A total of 300 chicken were vaccinated with BCRDV and RDV in regular interval. A total 60 duck were vaccinated with DPV. After vaccination program mortality rate significantly decreased. Napier and Sorghum were cultivated as fodder in Noakhali site and highest yield (8.13t/ha) observed in second cut at 67 days after sowing (DAS) whereas 5.32 t/ha green fodder was harvested from Sorghum grass after 53 to 55 DAS.

Fisheries development: Mixed carp fish culture and monoculture of monosex tilapia culture in the Seasonal mini ponds were conducted among six farmer at FSRD site Patuakhali and Noakhali during 2019. Average pond size was 10 decimal per farm family. After 7/8 months, ponds were dewatered completely to harvest all the fish. The average production of monosex tilapia was 235kg/10 decimal pond in Patuakhali and 230kg/10 decimal pond in Noakhali.



Fish culture at Noakhali

BRRRI component: A total of 12 farmers from two village of FSRD site Bishnupur, under Kaligonj Upazila of Sathkhira district were selected for carrying out the project activities. The farmers groups were marginal, small and medium and who have homestead, crops, livestock and fisheries component of farming systems. In homestead component: homestead and field near by homestead areas were under taken for high value and nutrient rich vegetables production.

Homestead production system: The vegetables, spices and fruits were grown during February 2019-January 2020 during Kharif-1, Kharif-2 and Robi season. The vegetable, spices and fruits were Potato, brinjal, country beans, sweet gourd, bottle gourd, bitter gourd, cucumber, purple yam, arum, giant taro, elephant foot, turmeric, ginger, papaya, guava, lemon, drumstick and banana. Improved production practices along with improved varieties were tested to increase total vegetables, spices and fruit production round the year using existing farm resources. Total productions of vegetables after twelve months were 5487 kg in 65 decimal. Average production of vegetables per homestead was 610 kg. Before intervention, average year round

vegetables production was 343 kg in similar area. It increased to 610 kg/65 dec. In the year 2018-19, the total production of vegetables was 6870 kg, which increased to 9150 kg in 2019-20. In the year 2018-19, the average production of vegetables per farmer was 1112 kg, which increased to 3050 kg in 2019-20. Increased production rate also increased consumption of vegetables by the farmers. In 2018-19, average consumption per farmer was 580 kg, which increased to 715 kg per farmer in 2019-20. Eleven families were motivated for planting Chui jhal spices with the support of perennial trees and nearby walls. A total of forty-one stems were given with ten farmers during 2018-19. The stems are still yet to be marketable in 2020.



Homestead vegetable production at FSRD site

Crops and cropping system: Two improved patterns Mustard (BARI sharisa 14) - Boro (BRRI dhan81) - T aman (BRRI dhan75) and Boro (BRRI dhan81) – Jute - Taman (BRRI dhan75) were tested against existing Boro – Fallow-T. Aman cropping pattern. Rice equivalent yield 15.24 was found from improved cropping pattern against 10.42 t/ha in existing cropping pattern. Another two cropping pattern Khira+Brinjal-BRRIdhan75 and Broccoli + Pumpkin-BRRI dhan75 have been tested against existing Vegetables-Rice cropping pattern during reporting period. In the improved pattern rice equivalent yield was 34.44, 33.51 respectively against 15.18 t/ha in existing one. To address salinity four cropping patterns Khira + Pumpkin -Jute- BRRI dhan75, Mustard -Mungbean-Jute- BRRI dhan75, Cabbage +Spines –BRRIdhan81- BRRIdhan75 and Mustard- BRRI dhan86- Jute-BRRI dhan75 were tested against existing cropping pattern BRRI dhan28-Fallow-BRRI dhan49. Rice equivalent yield of tested pattern was found 41.14 t/ha, 18.86t/ha, 33.03t/ha, 21.54t/ha and 10.42t/ha.



Development of alternate cropping pattern

Production program: Under production program four variety of BRRI released T. Aman rice for saline ecosystem were under taken. About one bigha land was taken under cultivation of each production program. Ten disperse farmers field were taken and the varieties tested were BRRI dhan71, BRRI 73, BRRI dhan75 and BRRI dhan87. BRRI dhan71 yielded 6.01 t/ha and BRRI dhan87 produced 5.98 t/ha while yield of BRRI dhan75 was 5.48 t/ha. BRRI dhan73 showed the lowest yield of 5.03 t/ha.



Development of alternate cropping pattern

Livestock component: Eight selected farmers were given 120 chicks (Each farmer 16) aged seven weeks for each. Among the distributed chicken 75% chicken survived. The egg production of chicks started after 50 days after distribution. Average number of eggs laid for each farmer was 799. Average cash income was 4460 Tk. per farmer. Each of the four selected farmers was given 17 Khaki Campbell duck aged six weeks. Average egg production 1236 and cash income 6968 Tk was found



Duck (Khaki Campbell) at farmers household

from each farmer during February, 2019 to January, 2020. Fifty Turkey chicks were distributed among five farmers. Average initial weights of the chicks were 300-350g. After 5-6 months age female birds started laying eggs. At about 7-8 month's duration Turkey birds gained commercial weight and ready for sale. Five farmers under small and marginal group were selected and each of them was given two Black Bengal doe collected from local market. Some goats were producing milk regularly which fulfil nutrition among the family members.

Vaccination program: PPR Vaccination of total 10 goats was done on 22nd June, 2019. Before the intervention, percent of mortality in the area was 30% but after intervention no mortality was recorded. Distributed poultry birds were vaccinated within a few days of dispersal. BCRDV and RDV vaccination was done for a total of 47 Turkeys on 1st July and 12th June on 2019. Hatched chicks were also vaccinated. RDV vaccination was done for a total of 68 Sonali chickens on 23rd June, 2019. DPV vaccination was done for a total of 38 Khaki Campbell ducks on 14th June, 2019.

Fisheries component: Eleven species of fish: Rohu, Catla, Silver carp, Grass Carp, Mirror Carp, Thai puti, Vangal, Coral, Faissa, Khorkhullu and Bagda and shrimp were cultured as poly culture of fish in Gher (136 decimal) with 06 farmers. Farmers completely harvested their Ghers in January, 2019. Before intervention farmers generally cultured Bagda and Coral in the Ghers, but after intervention different type of high value fishes like Khorkhullu, Vangal and Faissa introduced in the saline Gher system. Stocking density was 40-50 individuals per decimal, while Bagda was stocked at 3-4/m². The average production for six farmers was 670 kg, with average gross return Tk 184850 and BCR was 1.98. Fish poly-culture in mini pond system were also introduced with 06 farm families. Ten species of fish namely Rohu, Catla, Mrigel, Bata, Silver carp, Grass Carp, Mirror Carp, Black Carp, Tilapia, Thai puti were distributed. Average pond size was found 23 decimals. Stocking density was 30-40 individuals per decimal.



Fish polyculture in saline gher at FSRD site, Satkhira

BINA componnet: Twelve farmers were selected from two villages for conducting farming system research and development activities. The farmers group were marginal, small and medium and who have crops, livestock, fisheries and homestead component. The research areas under costal ecosystem were homestead production system, crops and cropping system, livestock production system and fisheries production system. Under this research area ten research and development activities were executed during February 2019 to January 2020.

Homestead production system: For year round vegetables production BARI developed Lau Dove model was followed where eight niches were utilized and implemented with 12 farmer during 2019-2020. Vegetables cultivated during Rabi season were red amaranth, spinach, cauliflower and bottle gourd etc. and in Kharif season were red amaranth stem amaranth, okra, indian spinach, elephant foot, white gourd, bitter gourd, sweet gourd, moulavikachu, panikachu and chuijhal on



Homestead vegetable production at Satkhira

roof top, papaya at backyard and yard long bean at home boundary fence. After intervention the vegetables production was increased by 400% in comparison to before intervention of the program. The total vegetables production in the homestead was 455kg homestead-1 year-1. The average vegetables intake, distribution and sold per farm family were 330 kg, 39 kg and 30 kg respectively. The gross return from vegetables per farm was recorded as Tk.8248 with the gross margin of Tk 5330 per family per year.

Crops and cropping system: The experiment was conducted at FSRD, Shyamnagar, Sathkhira during 2019-20 with improved cropping patterns Mustard (Binasarisha-9)-Boro (Binadhan-10)-T.Aman (Binadhan-17), tested against existing Fallow-Boro (Binadhan-10)-T. Aman rice (Jamaibabu). Higher net return Tk 123135/ha was obtained from improved cropping pattern, which was 164% higher than existing cropping pattern. Cost benefit ratio of improved cropping pattern was 1.56.



Mustard (Binasarisha-9) at Satkhir

Fruit tree plantation: A good number of quality fruit saplings were distributed among selected and surrounding farmers of the project areas at the FSRD, Shyamnagar, Sathkhira During 2019-2020. Under this program mango, litchi, dwarf coconut, lemon, guava, papaya, black pepper, Pumelo, custard apple, Sapota dragon fruit were distributed among the selected farmers. A total of 321 saplings of different fruit varieties were distributed to homestead.

Livestock component: A total of 20 cattle vaccinated with FMD and Anthrax during reporting period. Before the intervention, percent of mortality in the area was 10% but after intervention mortality was 2% recorded. Distributed poultry birds were vaccinated within a few days after distribution. BCRDV and RDV vaccination was done for a total of 60 Turkeys on 1st July and 12th June on 2019. A total of 204 duck were vaccinated against DPV. After vaccination program mortality present significantly decreased. Before intervention, mortality rate in the area due to duck plague was 15%. But after intervention mortality rate was only 3% due to duck plague. Each of the



Turkey rearing

12 selected farmers was given 12 Khaki Campbell duck aged six weeks (two male and ten female). Average egg production was 117 and cash income was Tk 834/farm house per month. Sixty Turkey chicks were distributed among 12 farmers. After survivable 40 Turkey were found among 12 farmers. Average initial weights of the chicks were 300-350g. After 6 months of rearing female birds has started laying eggs. Each farm family got 23 eggs and earn 380Tk. per month after six month of rearing. Average body weight gain 4.0 kg after six month of rearing of Turkey birds.

Fisheries component: Mixed carp poly culture is very popular technology in the seasonal pond in this area. Among seven target farmers, fingerlings were distributed and the growth of fingerlings was recorded. The survival rate of fingerlings was more than 80% in most of the cases. After intervention with new technology the total production increased 108% and income increased 23.97%. Total production, net income and cost benefit ratio were 2035kg/ha, 26112Tk/ha and 1.32 respectively.

34. Project Title: Fortification and standardization of nutritional level in selected human foods and efficacy test of polyphenolic compounds in livestock (ID 099)

Coordinator	: Member Director (Fisheries), BARC, Farmgate, Dhaka
Implementing organization	: BRRRI, BARI, BAU
General objective	: To control qualitative reduction/loss of food value and improvement of nutritional quality of rice, selected fruits/vegetable/herbal products through value addition
Duration	: Aug 2018 to Jul 2021
Budget	: Tk. 2,75,00,000/-

Background: Fish, meat, milk and their products including processed foods are also adulterated in different stages of processing and marketing. The foods of animal origin also adulterated by mixing or adding non-food ingredients, using preservatives, additives, coloring, flavoring chemical adulterants. Rice grain contaminated due to heavy metal contamination, pesticide contamination, fungal colonization and mycotoxin contamination which may affect the public health. The present research thus aims to generate new technology on the basis of available information on food contaminants, adulterants and other hazardous chemicals and to dissemination of ideas for awareness of consumers and towards establishing food safety. Value addition to seasonal crops is advantageous from many corners starting from loss minimization (loss 40%) to job creation. However, processing of seasonal produces into traditional products like jam, jelly, squash, sauces and different dried & dehydrated products have limited industrial interest due to slow and limited market coverage. Chips prepared from different fruits and vegetables are well known and popular snack food in the country. Jack-fruit, pineapple, mango, guava and papaya are some of the seasonal fruits which are susceptible to huge post-harvest loss. If they are processed into high quality popular snack products like chips, their post-harvest loss will be minimized, farmers will get fair price, production of them will be increased and finally food and nutrition security of producers and consumers will be obtained. Secondly fresh fruits and vegetables are rich in carbohydrates, fibre and vitamins. Thirdly, traditional deep fat oil frying results in low quality chips in terms of color especially from high sugar fruits (banana chips as an example). Deep frying develops deep brown and blackish color. This harness can easily be overcome by employing vacuum frying technology. By this method, frying will be carried out under vacuum pressure at low temperature and hence, product quality will be improved, nutrition loss will be minimized, degree of fried oil deterioration will be reduced and finally processing cost will be minimized. Rice is our staple food and the people of our country are taking nearly cent present of carbohydrate. As a result, there are a lot of people especially young kids and women are suffering from malnutrition mainly for vitamins and minerals. Hence, the fortification with vitamins and minerals are carrying need in the country for mitigation of malnutrition.

Progress:

BRRRI component: As per set objectives BRRRI attempted to know the dietary pattern of street children in the capital city of Dhaka so that formulation of low cost rice based nutritional food items can be developed. Under the activities of the component, a total of 384 interviewees were made as part of baseline survey on street children aged from 4 to 12 years old in capital city, Dhaka. The sample size was fixed by addressing Cochran equation. Among the interviewees 63% are male and 37% are female respondents of 384. Survey took place at 20 different hot spots covering both Dhaka city north and south into account. It has been

observed that 27-59% respondents are deficient in recommended dietary intake per day for 4 to 12 years old male boys. In case of girls 28-56% found deficient in recommended dietary intake per day (4 to 12 years old). As the energy dense rice biscuit (EDRB) has a potential of providing 515 Kcal/100 g serving (Table below) so, it could predict that incorporating improved rice-based product once a day in their daily intake will mitigate nutritional gap by 64 to 100% for street boys and noticeably 70 to 100% for girls. The project prepared rice biscuit (3.6% moisture) and rice cake (11% moisture) but due to high moisture content, cake was not found suitable for long time storage at room temperature. The EDRB biscuits are more suitable than EDRC cake in this regard to mitigate nutritional gap of street children in capital city, Dhaka.

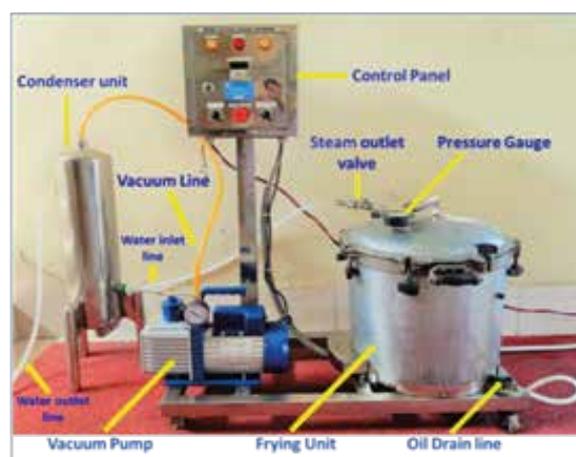


Sub-project activities

Table 3.18: Proximate analysis of EDRB (Energy dense rice biscuit)

Proximate components	Amount in g	Kcal/g	Estimated Kcal	Minerals	Amount/100g
Carbohydrate	57	4	228	Zn	2.50 mg
Fat	27	9	243	Fe	0.71 mg
Protein	10.6	4	42.4	Ca	3.80 mg
Dietary Fiber	1	2	2	Phos	125 mg
Ash	0.8	0	0	As	<0.1 ppm
Moisture	3.6	0	0	Pb	<0.1 ppm
Net weight	100	-	515.4	Cd	<0.1 ppm
Energy Density (ED)	5.2	-	515 Kcal	Ni	<0.1 ppm

BARI component: This component is responsible for simplification of selected processing equipment (vacuum fryer) and optimization of its operating parameters and development of value added products technology with appropriate packaging. Most of the people like to consume snacks item as well as fried products during travelling. Although it is a common item for kids and middle age group but it is dangerous for human health if any hazardous substances and carcinogenic compounds produce at the time of processing. Under the experiment, for smoothly perform the vacuum frying machine, the machine was a bit modified by attaching condenser unit between frying chamber and vacuum pump. Also, rotational speed of the de-oiling machine was modified. The speed was fixed at 1400 rpm for completing the de-oiling of fried chips products. This work was completely done by the local manufacturer with the help of the Farm Machinery and Postharvest Process Engineering Division, BARI and then few trials were conducted for preparing banana and jackfruits chips products.



For development of fried banana chips, banana slices are soaked into turmeric mixed solution for 3 hours to develop color as well as use as natural preservatives. Local banana variety and BARI Kola-1 which was produced through tissue culture were used in conducting few trials for developing protocol of quality banana chips products. Spices are another important ingredient to increase palatability of chips products. Spices ratio vary from product to product. Spices assist to enhance storage life of chips products as well as it acts as a biological preservative. Selection of proper spices combination was evaluated by an expert panelist comprises 10 members.



Prepared banana chips

Some preliminary trails were conducted to identify the suitable treatment for sweet potato chips development. Four different treatments were selected by evaluating sensory attributes with expert test panelists and then the best one (Highest sensory score obtained in treatment B) was chosen to conduct the experiment. Field sample of the local real potato chips available in different locations of the country differ in their physical appearance (external color) and nutritional qualities. Moisture content, crispiness and oil content had significant differences due to different processing techniques, packaging system and marketing pattern. There was not known appropriate processing technique such as proper slice thickness, frying time, frying temperature, oil temperature, proper packaging materials etc. that's why variation was observed in the quality parameters of local potato chips products. So far the achievement of the component are:

- A small scale simplified and fabricated vacuum frying machine was modified by adding condenser unit for smooth working.
- A de-oiling machine fabrication was completed with fixed speed at 1400 rpm during release the excess oil from the fried chips product.
- Processing protocol for fried banana chips product was obtained.
- Suitable spices combination was figured out for vacuum fried banana chips product.
- Experimental design completed for vacuum fried banana chips development and experimentation is in progress for optimizing the quality parameters.
- Nutritional quality parameter of the local potato chips was evaluated.
- A trial experiment was conducted to optimize the vacuum fried sweet potato chips processing parameters and experimentation is in progress for physico-chemical quality and shelf life study of the fried chips product.

BAU component: BAU executed the study through the detection of plant phytochemicals like organic phenol, flavonoids, saponin, tannin, carotenoids contents from different herbs that are locally available by thin Layer Chromatography and after that preliminary screening, quantification of phytochemical profiles in most potential herbs by using LC-MS for nonvolatile, GC-MS for volatile known compound and NMR for unknown compound. Then in-vivo field trail with selected herbs with good PCs profiling found during quantification. In-vivo trail would



Plantation of herb (Mint plot)

be performed in dairy cows, beef cattle, sheep and poultry in Shahjalal Animal Nutrition Field Laboratory and farmer level to find actual performance potential, determination of correct threshold level, digestion and absorption dynamics by metabolic trail, plasma biomolecules profile through colorimetric method, using different kits for determination of metabolites in bio-analyser, hormonal assay by ELISA, determine the fatty acid profile of meat, milk and egg by LC-MS & GC-MS and threshold level of PCs as antioxidant retain in the meat, egg and milk could be determine by LC-MS/GC-MS.

Growth performance of broiler

The all experimental treatments involved T₀, T₁, T₂ at the initial stage all bird weight were almost similar. There was no statistically significant difference of live weight of broilers at 8th, 16th, 24th days of all experimental treatments. But numerically higher live weight was found in T₁ group compared to other two dietary treatments at the 8th, 16th, 24th day. At final stage 32th day, statistically significant higher body weight was found in T₁ group compared to the other treatments (Table 3.19).

Table 3.16: Live weight (g/bird)) of broilers under different dietary treatments after 8 days interval

Age	Treatments			SEM	P-Value
	T ₀	T ₁	T ₂		
0 Days	41.33±1.52	41.33±1.52	41.00±2.00	0.98	0.962
8th Day	158.50±12.90	167.82±9.91	145.80±10.00	6.36	0.124
16th Day	479.05±11.11	494.19±6.79	462.74±10.11	5.07	0.013
24th Day	855.33±10.796	869.32±10.26	802.62±9.02	5.80	0.004
32th Day	1612.80±13.22	1650.40±7.56	1596.20±6.50	5.52	0.001

T₀ = Formulated diet + AGP (Control), T₁ = Formulated diet + 1.0 % (DM) Shade dried herb mixture (composed of Plantain herbs, ivy gourd, mint and garlic leaves), T₂ = Formulated diet + 1.0 % (DM) Blenching force dried herb mixture

Growth performance of sheep

As stated in table, there was no significant (P=0.554) difference of initial live weight was observed among the treatments groups. Herbal supplementation significantly (P=0.001) increased the live weight of sheep compared to CON-diet. Higher live weight was obtained at PL-diet, then PI- diet and IG- diet, respectively. Addition of herbal supplementation with CON-diet significantly (0.001) raised the total live weight gain of sheep compared to CON-diet. Average daily gain (ADG) was significantly (P=0.000) elevated in herb supplemented group compared to CON-diet. Herbal supplementation improved 15-24% average daily gain compared to CON-diet. PL, IG and PI-diet showed significant result in term of growth rate compared to CON-diet. PL- IG and PI-diet obtained 25, 15 and 14% better growth rate compared to CON-diet. Significant feed (P=0.001) and crude protein (P=0.000) intake were calculated at herbal supplementation groups compared to CON-diet. Feed conversion ratio (F.C.R.) significantly (P=0.002) lower in herbal supplemented groups that is good indicator for sheep production i.e. less feed is required for higher mutton production. Better FCR was calculate in PL-diet, then IG-diet and PI-diet that were significant compared to CON-diet (Table 3.20).

Table 3.20: Effect of herbal supplementation on growth performance of sheep

Parameters	Treatments				SEM	P-Value
	CON-diet	PL-diet	IG-diet	PI-diet		
Initial LW (Kg)	8.40±0.02	8.39±0.04	8.43±0.04	8.40±0.03	0.008	0.554
Final LW (Kg)	11.32 ^b ±0.07	12.03 ^a ±0.16	11.80 ^a ±0.15	11.88 ^a ±0.12	0.085	0.001
Total LWG (Kg)	2.93 ^b ±0.08	3.63 ^a ±0.16	3.37 ^a ±0.12	3.48 ^a ±0.09	0.084	0.001
ADG (g/day)	46.45 ^b ±1.27	57.67 ^a ±2.57	53.54 ^a ±1.92	55.29 ^a ±1.38	1.342	0.000
GR (%)	34.86 ^b ±1.00	43.29 ^a ±1.94	40.02 ^a ±1.28	41.45 ^a ±0.90	1.001	0.001
DM intake (g/day)	315.13 ^b ±3.00	342.15 ^a ±8.28	335.00 ^a ±2.78	333.10 ^a ±2.62	3.225	0.001
CP intake (g/day)	43.42 ^c ±0.96	47.67 ^a ±0.54	45.80 ^b ±0.46	47.17 ^{ab} ±0.59	0.540	0.000
FCR (g DM/g gain)	6.79 ^a ±0.16	5.94 ^b ±0.13	6.26 ^b ±0.26	6.02 ^b ±0.16	0.109	0.002

CON-diet: Roadside grass, wheat bran, mustard oil cake, broken maize and common salt, **PL-diet:** CON-diet + 10g DM of Plantain supplementation; **IG-diet:** CON-diet + 10g DM ivy-gourd leaf supplementation; **PI-diet:** CON-diet + 5 g DM of plantain and 5 g DM of ivy-gourd supplementation, **LW=** live weight, **TLWG=**Total live weight gain, **ADG=**Average daily gain, **GR=** Growth rate, **DM=**Dry matter intake, **CP=**Crude protein, **FCR=**Feed conversion ratio, g = gram, *Significant (P<0.05); **Significant (P<0.01) ***Highly significant (P<0.000); **NS**, Non-significant (P>0.05), **SEM=**Standard Error of Mean.

The shade dried herb mixture was grinded by grinder machine at Shahjalal Animal Nutrition Field Laboratory for Layer trial and kept at normal temperature. Besides, the plantain and ivy-gourd herb were selected for sheep trail. The threshold level of herbs in sheep were determined by the fund of CRG, MOP and including this. The sheep was showed better performance at 10g DM of plantain herb, 10g DM of garlic leaf and 5+5 g DM of plantain and garlic leaf, this research was published at Journal of Animal in last issues. From these, 10g DM of plantain and 10g DM of ivy-gourd, both herbs at 5g DM of plantain and garlic leaf were offered to the sheep, as no previous study was not performed on sheep about mutton quality and osteoporosis.

35. Project Title: Contamination and adulteration of food and food products, process, chain and mollification (ID 103)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka

Implementing organization : BARI, BFRI

General objective : Prevention or minimization of hazards through improved culture and post-harvest practices and ensure food and food chain safety in fruits, vegetables and fish products

Duration : Jan2017 - Jun 2021

Budget : Tk: 31991600/-

Background: The food chain is a complex, concentrated and dynamic chain of activities that onsets with the production of raw agricultural commodities on field and moves to value-added fresh, processed and manufactured products and then to retail food stores, wholesale market, and food service establishments (restaurant and institutions). During harvesting, preparation, processing, packaging, storage, and distribution food is contaminated with soil, air, and waterborne microorganisms. As a relatively “high-risk” food, fish and fishery products are subject to a range of food safety requirements related to general hygiene and specific microbiological and chemical contaminants. There are always a potential for fish and fish products to be contaminated by pesticides, heavy metals and pharmaceutical compounds either from direct or indirect sources. These potential problems can occur on the farm, during processing, or at the wholesale/retail levels. The lack of knowledge concerning the effects and fates of chemicals and their residues, antibiotics in farmed fishes and fish products lead this research concept with the major concern of food safety in fisheries sub-sector. Therefore, this study is important to determine the effects of growth hormone in aquaculture and to determine heavy metal contaminants’ in marine fish and fish products from the coastal water. Furthermore, data of this study could also be used to economically protect local and export market of the fish industries in Blue economy of the country. In addition, it also gives important information on the safety aspect of local fish as consumer now-a-days is aware on the beneficial intake of fish particularly for its nutritive values.

Progress:

BARI component: A survey was conducted in two districts namely Tangail and Chapainawabganj for generating information regarding hazards and hygienic condition of selected fruits in supply chain. A total of 60 samples having 30 from each of the two districts were randomly selected by the pre-tested questionnaire. Farmers applied pesticides with higher dosages and frequencies (10-12 times) per season than the recommendation level. To attract consumers, farmers use plant growth regulator (PGR) to get bigger size pineapple round the year in Tangail district.

An experiment was conducted to detect naturally produced formaldehyde in fruits and vegetables. Some fruits (grape, apple, jackfruit, mango) and vegetables (cauliflower, red amaranth, tomato, data shak, cabbage, brinjal, indian spinach, spinach) were collected from local market and analyzed to estimate the amount of formaldehyde which was produced naturally. Naturally occurring formaldehyde was detected in grape 2.43 ± 0.66 ppm, apple 8.69 ± 1.07 ppm, jackfruit 9.63 ± 0.19 ppm and mango 10.27 ± 0.23 ppm. In vegetables, formaldehyde was estimated in cauliflower 2.26 ± 0.52 ppm, red amaranth 1.49 ± 0.12 ppm, tomato 3.81 ± 1.14 ppm, data shak 3.57 ± 0.78 ppm, cabbage 2.34 ± 0.49 ppm, brinjal 2.69 ± 0.91 ppm, indian spinach 1.77 ± 0.71 ppm and spinach 2.62 ± 0.52 ppm respectively.

Another study detected and quantified the heavy metals (Pb, Cd, As, Cr, Ni, Co, Fe) in different water sources (tube well, canal, river, market) of Gazipur. The result showed that, three heavy metals were traced in six different sources of samples. The highest amount of Cr (136 ppm) was detected in collected water sample of Gazipur market area. Ni (0.038 ppm) and Co (0.017 ppm) were present in tube well water samples from Kapasia. The highest amount of Fe (1.041 ppm) was found in canal water samples collected from Kapasia, Gazipur. Three sanitizer agents and another two treatment (with tap water wash and without tap water wash) for controlling microbial growth were applied to evaluate the efficacy test of tomato (var. BARI tomato-14). Trisodium phosphate (1%), acetic acid (0.5%) and calcinated calcium (0.01%) were used. The result showed that calcinated calcium (0.01%) and acetic acid (0.5%) were more effective of tomato fruit during 15 days of storage at ambient condition ($26 \pm 2^\circ\text{C}$ & $80 \pm 5\% \text{RH}$).

Two experiments were conducted to standardize the ethylene gas concentration for uniform ripening of matured mango (*Mangifera indica*) and tomato (Breaker stage). The data were recorded up to 6 days at 2 days of intervals during storage. In treated mangoes ripening process initiated after 36 hours calculated from the time of exposure to exogenous ethylene application whereas the control treatment the time duration was 72 hours. The result showed that there is negligible changes in different biochemical compositions and in different physical attributes. It was also observed that mangoes harvested at mature green stage can easily be exposed to ethylene concentration (100-150 ppm) for 24 hours in order to uniform ripening and early marketing maintaining better quality where the residue level is below the MRL. For dose standardization of tomato fruit uniform ripening, three different treatments such as 100, 200 and 300 ppm ethylene gas concentration and another treatment was without application of ethylene considered as control treatment. Two ripening chamber were set at 20°C and relative humidity was 85±5%RH for experimentation. The fruit was examined to evaluate uniform ripening time with nutritional quality for each treatment. Each treatment comprised three replications at the interval of 0, 3, 6, 9, 12 days where ambient storage condition (20°C & 75±5%RH). The experiment was completed but data analysis was in progress due to Corona pandemic situation.



Treated with 150 ppm C₂H₄ after 4 days

Table 3.21: Effect of ethylene on ripening, weight loss, titratable acidity and TSS of mango during storage

Treatments	Ripening (%)			Weight loss (%)			Titratable acid (%)			TSS (⁰ Brix)		
	2 DAS	4 DAS	6 DAS	2 DAS	4 DAS	6 DAS	2 DAS	4 DAS	6 DAS	2 DAS	4 DAS	6 DAS
T ₁ (Control)	28.30	50.00	80.00	1.13	1.34	1.74	0.83	0.72	0.77	10.60	11.23	12.80
T ₂ (100 ppm)	38.18	65.55	100.00	1.75	2.35	2.84	0.83	0.81	0.73	10.50	16.32	20.70
T ₃ (150 ppm)	42.34	100.0	100.00	2.75	3.23	3.73	0.78	0.71	0.70	10.40	17.23	20.90
Level of significance	***	***	***	Ns	*	*	ns	ns	ns	ns	***	***
LSD	1.67	3.46	3.99	1.63	1.63	1.15	0.20	0.20	0.20	0.20	1.63	1.74

*DAS=Days after storage, Data presented are mean of three replications, NS = Not significant

BFRI component: It conducted feeding trial for a period of 90 days to evaluate efficacy of two commercial fish growth promoters i.e. Maxgel and Growmax on the aquaculture production of Tilapia (*Oreochromis niloticus*) and Shing (*Heteropneustes fossilis*) in mixed culture, and Koi (*Anabas testudineus*) in monoculture system at farmers' pond using commercial fish feed (Mega Feed). Growth promoters did not showed positive growth increment of cultured fishes in comparison to control (without growth promoter). Growth promoters revealed quality improvement of fish muscle when fatty acid profile of cultured fishes were estimated. Better fish muscle quality resulted from Maxgel in case of tilapia and Growmax resulted better muscle quality for koi. Investigation was carried out on distribution of certain faecal indicator and pathogenic bacteria from the water and fish sample of fish landing centres of Chandpur and Barisal during post monsoon season. During the investigation, among the pathogenic bacteria, the *Vibrio cholerae* were maximum in the study sites

(4-8×10⁶ CFU). Among the two landing sites, the total coliform and the faecal coliform were higher numbers in Chandpur indicating poor sanitary condition than Barisal. Moreover, certain microbial analyses were applied to assess the quality of 5 fish species i.e. *Tenulosa ilisha*, *Labeo rohita*, *Catla catla*, *Ompok pabda* and *Oreochromis niloticus* landed in those landing sites. Among the fish tissues examined, the highest counts of total plate, total coliforms and *Salmonella* spp. were recorded from the hilsa (*T. ilisha*) and lowest from catla (*C. catla*) and tilapia (*O. niloticus*). Highest counts of pathogenic bacteria were recorded in gill tissues than skin of all fishes under study. Proper sanitation and handling should be taken to improve the fish quality in the landing centers, which also reduce the post-harvest losses. Further study will be conducted to compare seasonal variation of microbial contamination in fish landing centers.



Feeding trial of tilapia, shing and koi at farmer's pond

Concentrations of 6 heavy metals Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu) and Zinc (Zn) in the muscles of four fish species- koi (*Anabas testidineus*), shing (*Heteropneustes fossilis*), pabda (*Ompok pabda*) and prawn (*Macrobrachium rosenbergii*) from aquaculture and wild sources were estimated. The average heavy metal concentration in fish muscles varied in a decreasing order of Zn > Cu > Cr > Cd > Pb > As. This study also showed that Zinc was predominant, while Arsenic was the least accumulated metal in the muscles of the studied fish. Prawn represented highest accumulated metal both from culture and wild sources. More investigation will be carried out to compare seasonal variation of metal accumulation in cultured and wild fishes of commercial importance.

36. Project Title: Development of knowledge hub on feed resources for efficient feeding management of livestock (ID 108)

Coordinator	: Member Director (Livestock), Livestock Division, BARC, Farm gate, Dhaka-1215,
Implementing organization	: BLRI, BAU, SAU
General objective	: To generate information for establishing national feed inventory on detailed feeds and fodder available in the country, their chemical composition and nutritive value, which would ultimately help to model the specific feeding program in different regions and seasons over the year.
Duration	: May 2018- Jun 2021
Budget	: Tk: 1,69,32,244/-

Background: Feed is the foundation for efficient livestock production and linked with major inputs and outputs. Estimation of feed balance at national and farm level would help to identify the feed vis-à-vis nutrient balances (Dry Matter, Crude Protein and Metabolizable Energy). This also helps in spatial and temporal assessments of current and forecasted feed resources which ultimately would help for efficient feed management strategies and in establishing feeding standards. The information rights and access to right information is the top priority areas of the government's mission for Digital Bangladesh. To exploit this policy, Access to Information (a2i) is on-going process for increasing the service provisions to the people of all concerns based on reduction of TVC (TVC stands for Time, Visit and Cost). However, this is not yet sure whether the information on feed and nutritional value would be ensured or not. The proposed sub-project would address this as this study would launch online database which would be interactive so that all farmers can get easy access to the right information on feeds.

The farmers who are treated as the center of the livestock development wheel as they will steer the wheel of progressing the livestock sub-sector, will get benefit from this study. Therefore, the proposed sub-project is of high relevance to the nutritional, economic and development perspectives of the country. The proposed study will address those limitations and would provide an excellent basis for developing interactive and dynamic knowledge hub on animal feed resources and related issues as well as also help to make step forward for locally applicable feeding standards. Considering the fact the project is designed to generate information for establishing national feed inventory on detailed feeds and fodder available in the different agro-ecological zones in the country along with their chemical composition and nutritive value of feeds.

Progress: To fulfill the objectives of the sub-project, a series of both field survey and on-farm experimental trial has been planned to perform over the three years. The study is being done in eight divisions (Dhaka, Khulna, Chattogram, Rajshahi, Rangpur, Mymensingh, Sylhet and Barishal) covering ten districts and 16 upazilas from the selected districts. Thirty feed samples per location have been planned to be collected for chemical and nutritive analysis covering summer, rainy and winter seasons. The major activities that were performed during the last one year period were: i) Review of literature (80 secondary sources), collection of secondary information on feed availability, collection of feed composition and nutrient requirement data from different laboratory, journal and proceedings; ii) Field Survey and inventory of available feedstuffs of different agro-ecological zones of Bangladesh; iii) The samples were collected from the field, and iv) The chemical composition analysis is in progress for determining dry matter, crude protein, crude fibre, nitrogen free extract, ether extract and ash using the method of AOAC (2010). The in-vitro method was applied for estimating the energy content of feeds and fodder. The meta-analysis (which was assigned solely to BAU) is in progress. So far, chemical analysis of the collected feed samples completed by the component institutes includes BLRI 106, BAU 57 and SAU 32. SAU was also able to estimate mineral components of the 50 feed samples. BAU was able to conduct in-vitro analysis of 11 samples and meta-analysis of 11 samples. According to BAU and SAU report the highest milk production in the study areas was 8-15 kg/cow/day and lowest was 2kg/cow/day. According to SAU report the average paddy yield, ton per hectare was 4.7 and straw production was 7.6 ton. Average Harvest Index (Paddy : Straw) was found to be 1:1.63 and the extraction ratio of rice and rice bran (Polish + Husk) was 2.5:1. Major constraints hampering smooth progress of the sub-project was identified to be the COVID- 19 pandemic.



Fodder especially forgoe user in Mymeinsigh Sadar

37. Project Title: Application of gamma-ray irradiation to develop stress tolerant capability in fodder crops and their production performance under on-station and on-farm conditions (ID-110)

Coordinator : Member Director (Livestock), Livestock Division, BARC, Farm gate, Dhaka-1215

Implementing organization : BLRI, BINA

General objective : To develop stress tolerant fodder varieties for southern part of Bangladesh

Duration : May 2018 - Jun 2021

Budget : Tk: 93,18,569/-

Background: More than 30% cultivable lands which are located in coastal area of Bangladesh. Out of them, 1.056 million hectare lands are affected by different degrees of salinity (BARC, 2013). Salinity intrusion increased by 27 % from 1973 to 2009 (SRDI, 2010). Northwestern regions of Bangladesh are particularly exposed to drought. Among the drought prone areas of Bangladesh, the Barind region, the majority of households involved in livestock farming. The agricultural drought, linked to soil moisture scarcity, occurs at different stages of crop growth, development and reproduction. Apart from the agricultural loss, drought has important effect on livestock population, land degradation, health and employment. The northeastern part of Bangladesh is known locally as the hoar area (water-logging/wetlands) and consists of mainly the districts of Sunamganj, Moulvibazar, Sylhet, Kishoreganj and Netrokona. Virtually all of this land is below 8 meters and is flooded for 7- 8 months to depths of 5 meters or more during the monsoon. Feed shortage is the major reason for low productivity of livestock in Bangladesh especially in these areas. Livestock mainly survives on the common local grasses. More than 93 % farmers fed paddy straw to their cattle and cut & carry of natural grasses are common in these area that is not available throughout the year. The demand of fodder production is increasing today because of limited listed livestock feed resources in the country which is suitable for climate change adaptation. Improvement or development of new stress tolerant fodder germplasm will help to increase production and productivity of farm animals in the country.

Progress: Gamma ray irradiation is an efficient tool to produce mutants in different crops. Irradiation- induced mutations have also succeeded in forage grasses and turf grasses. In order to get good quality and high biomass yielding fodder, we set an experiment consisted of seven BLRI Napier cultivars as, Napier-1, napier-2, Napier-3, Napier-4, Rokona, Pakchong and Markiron one Para and one German grasses. The cuttings of each cultivar was irradiated with four does of Gamma rays as 2Gy, 30 Gy, 40Gy and 50 Gy from ⁶⁰Co source from BINA. These irradiated cuttings were transplanted at 60cmx60cm plant to and row to row distance along with control (non-irradiated). Irrigation and fertilizer were applied as and when necessary. It was observed survival percentage varied due to the effect of different dose of gamma rays. It ranged from 0-78%; and the control has the highest survival rate (78% in Para grass) and most of the cuttings in higher radiation dose like 40Gy and 50Gy didn't survive. It was found that out of 9 fodder cultivars,



Salinity screening of different mutants Napier cultivars

20Gy treated plants produced higher fresh weight in Napier-2, Napier-3, Rokona, Markoron, Para and German grass; whereas, 30Gy treated plants produced higher fresh weight in Napier-1, Napier-4 and Pakchong. They produced higher fresh weight than those of control plants (parents) except in few cases. On the basis of higher fresh weight and plant type (bushy and compact growth), 28 plants (17 from 20Gy and 11 from 30Gy) were selected and re-grown as M2 clones for agronomic evaluation. Samples were taken to assess nutritional quality of these selected clones. It was found that there is no significant changes occur in different nutritional component like dry matter (DM), ash, crude protein (CP), acid digestible fibre and non-acid digestible fibre contents, among the mutants with parent except in few cases. Crude protein contents increased in some mutants as compared with their parent. In salinity stress experiments, selected best mutants from seven Napier cultivars were exposed to salinity stress of 8dSm^{-1} , 10dSm^{-1} and 12dSm^{-1} of EC. Two-week old cuttings were used for these stresses. Continuous salt stress was imposed for four weeks and 10 salt tolerant clones (4 from 8dSm^{-1} , 4 from 10dSm^{-1} and 2 from 12dSm^{-1}) were selected on the basis of visual symptoms, growth and survival ability under salinity stress. For identification of salt tolerance gene(s) some potential genes such as NHX, SOS1, AKT and HKT family, expression studies were conducted in clones of six Napier cultivars under 15dSm^{-1} ($\sim 150\text{mM NaCl}$) stress. The expression of NHX1, NHX2, SOS1, HKT family and AKT transporter genes were carried out through semi-quantitative RT-PCR. Upon NaCl stress, most of the genes were up-regulated till 72 hours of salt stress except in few cases. The transcript level of Na^+/H^+ antiporter genes NHX1 and NHX2 were up-regulated significantly in most of the clones of Napier-1, Napier-2, Napier-4 and Rokona. The expression of HKT7 and SOS1 were significantly found in Napier-1, Napier-2, Napier-3 and Pakchong clones. The results were measured by a semi-quantitative RT-PCR method under 150mM treatments of NaCl and suggest that the salt-tolerant clones regulate the high levels of expression of above transporter genes related to high salinity tolerance.

Gamma ray irradiation is an efficient tool to produce mutants in different crops. Irradiation- induced mutations have also succeeded in forage grasses and turf grasses. In order to get good quality and high biomass yielding fodder, an experiment was set with seven BLRI Napier cultivars: Napier-1, Napier-2, Napier-3, Napier-4, Rokona, Pakchong and Markiron including one Para and one German grasses. The cuttings of each cultivar was irradiated with four doses of Gamma rays as 20Gy, 30Gy, 40Gy and 50Gy from ^{60}Co source from BINA. These irradiated cuttings were transplanted at 60 cm x 60 cm plant to plant and row to row distance along with control (non-irradiated). Irrigation and fertilizer were applied as and when necessary. It was observed that most of the cuttings of higher radiation dose like 40Gy and 50Gy didn't survive. Variations were observed in all the doses of gamma irradiations. Out of 9 fodder cultivars, 20 Gy treated plants (clones) produced higher fresh weight in Napier-2, Napier-3, Rokona, Markoron, Para and German grass. In case of 30Gy treatment Napier-1, Napier-4 and Pakchong produced higher fresh weight. On the basis of higher fresh weight and plant type (bushy and compact growth), 28 plants (17 from 20Gy and 11 from 30Gy) were selected with a view to re-grow in next season. Among these selected lines (clones), better lines will be further selected to release as mutant fodder variety(s) in future. In order to verify the extent of genetic variability among contrasting irradiated fodder cultivars, selected cultivars will be analyzed through DNA markers. For selection of salt and drought tolerant fodder clones, artificial screening will be conducted under hydroponic culture. For identification of salt, drought and flood/water logging tolerance gene(s) some potential genes such as NHX, DREB and HKT family genes will be selected and a set of forward and reverse primer for each gene will be designed for screening these genes from the salt tolerant clones. In this sub-project, BARC coordinate and monitor the activities of other components like BINA and BLRI with their Specific objectives

Jute germplasm have been characterized morphologically by BJRI. Totally 41 sugarcane germplasm have been characterized at morphological level by BSRI. Morphological characterization of 41 germplasm (31 rice and 5 chillis) has been completed by BINA. Morphological characterization of 233 cotton germplasm has been completed by CDB. Bangladesh Sericulture Research and Training Institute (BSRTI) have completed 45 mulberry genotypes characterization at morphological level. Indigenous germplasm of 65 banana, 31 yam and 35 aroids have been characterized morphologically by BAU.



Molecular characterization: Molecular characterization of target crops is going on and characterization at molecular level of 23 mustard germplasm using SSR marker has been completed by BARI. In case of BRRI, Molecular characterization of 48 germplasm of Boro 2018-19 was completed using 58 SSR markers where 55 markers were identified as polymorphic. On the contrary, DNA extraction of 48 germplasm of Aus 2019 was completed except data scoring using 60 SSR markers. Molecular characterization of 22 Jute germplasm has been completed by BJRI. Molecular characterization of 25 sugarcane germplasm is going on. Twenty rice germplasm have been characterized at molecular level by BINA and other crop molecular characterization is going on. Molecular characterization of 65 banana and 35 aroids germplasm has been completed by BAU and 31 yam molecular characterization is going on. Project activities in all the component organizations are going on smoothly as per project proposal.

39. Project Title: Determination of critical limit of nutrients for major soils and crops (ID 134)

Coordinator	: Member Director (NRM), BARC, Farmgate, Dhaka
Implementing organization	: BARI, BRRI, BINA, BAU
General objectives	: Delineation of the present status of different nutrients in calcareous, non-calcareous, piedmont and terrace soils and to validate critical limit of different nutrients for cereal, vegetable and oilseed crop through field experiments
Duration	: Mar 2018 to Jun 2021
Budget	: Tk 3,28,61,110/-

Background: Soil testing is a useful tool for measuring extractable (available) quantity of a nutrient in soil which would help predict the crop yield response to an application of that nutrient through fertilizers/manure. As soil test value for a particular nutrient increases, the crop yield response to an addition of that nutrient decreases. A good soil test should be able to predict the amount of plant-available nutrient as well as the fertilizer responsiveness of crops growing on a wide range of soils. In this regard, determination of critical limit (C.L.) is important to determine optimum fertilizer requirement for a crop. Now the country's soils are reported to be deficient in N, P, K, S, Mg, Zn and B. Critical limit of a nutrient in plant refers to a level at or below which plant either develops deficiency symptoms or causes reduction in crop yields as compared to optimum yields. Critical limit is useful for delineating responsive (deficiency) sites from non-responsive

(sufficiency) sites. The C. L. of a nutrient varies with crops, soils and extraction methods. Hence, the situation justifies a need to design the sub-project to determine and update the critical limit of different plant nutrients in order to formulate an optimum fertilizer dose of deficient nutrients for different crops and soils for achieving satisfactory crop yield.

Progress: The project is coordinated by BARC; and BARI, BIRRI, BINA and BAU are working as implementing organization.

Table 3.22: Work distribution among different components

Organization	AEZ	Nutrient	Crop
BARI	11, 13, 28	K and Zn	Wheat, maize and cabbage
BIRRI	18, 19, 20	P, K, S and Zn	Rice
BINA	25, 26, 27	P and Mg	Maize and mustard
BAU	1, 3, 9	Mg, S and B	Wheat and mustard

Twelve AEZs have been selected as the study areas under the project. A bench mark survey was conducted in the study areas to know the present nutrient and fertilizer use. Total 720 soil samples (4 components x 3 AEZs/component x 2 Upazilas/AEZ x 3 villages/Upazila x 10 spots/ village) were collected and analyzed for macro- (N, P, K, Ca, Mg & S) and micro- (Fe, Mn, Cu Zn & B) nutrients and basic soil characteristics like pH, organic matter and texture. Soils with different nutrient levels have been identified, which will be collected for pot experiments. The pot experiments were conducted during Rabi season 2019-20. To determine critical limit of a particular nutrient and crop pot experiments were conducted by the component organizations using soils with different levels of that particular nutrient and crop. At least 20 soils from 20 locations were used for one nutrient, of which 12 soils were of low fertility level, 4 soils were of medium fertility level and the remaining 4 soils were of high fertility level of the particular nutrient. Pot trials were conducted in CRD (completely randomized design) with two treatments (with and without intended nutrient) and three replications. Sprouted seeds of the test crops were sown in the pot and the crop was harvested at 8-10 weeks after seeding. Dry matter (DM) yield was recorded and plant samples were analyzed for all elements. Critical limit for a particular nutrient and crop was determined by Cate and Nelson method (1965) and also by statistical approach developed by Waugh et al. (1973). The results will be validated through field experiment at the farm level.



Pot trial on wheat with and without K application by BARI during 2019-2020

Staff recruitment and bench mark information collection have been completed. Each implementing organization collected 180 soil samples from their assigned locations i.e. a total of 720 soil samples were collected by four implementing organizations following the sampling protocol as mentioned above. GPS reading of soil sample collection points have been recorded. All the samples were analyzed for macro- (N, P, K, Ca, Mg & S) and micro- (Fe, Mn, Cu Zn & B) nutrients and basic soil characteristics like pH, organic matter, texture etc. The analytical data for different nutrients of all 720 soil samples were pooled together in an Excel sheet and sorted in ascending order. Soils having Low, Medium and High levels of the test nutrients were identified. Based on this analysis, locations for bulk soil collection for pot trials were selected. Soils for pot

trials on the above mentioned nutrients were collected for from the selected locations by the respective component organizations. All the pot trials have been completed by the component organizations on their specified nutrients and crops during Rabi season 2019-20, except one trial with K on maize by BARI, which is being conducted during current Kharif-I season 2020. Critical limits of the nutrients were estimated from the results of pot trials by the respective organizations, which will be validated with field experiments in the coming seasons. The estimated critical limits compared to the present critical limits (as in FRG-2018) for different nutrients and crops are presented in the table below:



Pot trial on Boro rice with and without P at BRRRI, Gazipur during 2019-2020

Table 3.23: Critical Limits of different crops and nutrients estimated by different component organization

Nutrient	Crop	Present CL (FRG-2018)	Estimated CL	Estimated by
Phosphorus	Rice	8.00 mg kg ⁻¹	8.70 mg kg ⁻¹	BRRRI
	Maize (Rabi)	10 mg kg ⁻¹	16.1 mg kg ⁻¹	BINA
	Maize (Kharif-I)	10 mg kg ⁻¹	14.5 mg kg ⁻¹	BINA
	Mustard	10 mg kg ⁻¹	14.8 mg kg ⁻¹	BINA
Potassium	Rice	0.12 meq 100 g ⁻¹	0.09 meq 100 g ⁻¹	BRRRI
	Wheat	0.12 meq 100g ⁻¹	0.17 meq 100g ⁻¹	BARI
	Cabbage	0.12 meq 100g ⁻¹	0.18 meq 100g ⁻¹	BARI
Magnesium	Maize (Rabi)	0.50 meq 100g ⁻¹	0.60 meq 100g ⁻¹	BINA
	Maize (Kharif-I)	0.50 meq 100g ⁻¹	0.52 meq 100g ⁻¹	BINA
	Wheat	0.50 meq 100g ⁻¹	0.50 meq 100g ⁻¹	BAU
	Mustard	0.50 meq 100g ⁻¹	0.55 meq 100g ⁻¹	BAU
	Mustard	0.50 meq 100g ⁻¹	0.59 meq 100g ⁻¹	BINA
Sulphur	Rice	10.0 mg kg ⁻¹	16.1 mg kg ⁻¹	BRRRI
	Wheat	10.0 mg/kg	13.5 mg/kg	BAU
	Mustard	10.0 mg/kg	14.0 mg/kg	BAU
Zinc	Rice	0.60 mg kg ⁻¹	0.70 mg kg ⁻¹	BRRRI
	Wheat	0.60 mg kg ⁻¹	0.69 mg kg ⁻¹	BARI
	Cabbage	0.60 mg kg ⁻¹	0.75 mg kg ⁻¹	BARI
Boron	Wheat	0.20 mg/kg	0.30 mg/kg	BAU
	Mustard	0.20 mg/kg	0.25 mg/kg	BAU

40. Project Title: Improvement of soil health and crop productivity of major problem soils of Bangladesh through organic amendments (ID 135)

Coordinator : Member Director (NRM), BARC, Farmgate, Dhaka

Implementing Organization : BARI, BRRI, BINA, BAU, BSMRAU, SAU

General Objective : Bio-physicochemical characterization of soil in the climate vulnerable and polluted areas by examine the potentiality of different organic materials for amending problem soils and improving crop yields in the study areas;

Duration : Mar 2018 to Jun 2021

Budget : Tk 3,71,26,906/-

Background: Climate change, buildup of soil salinity and acidity, development of heavy metals including arsenic are major concerns which degrade soil health and hinder crop production. High concentration of different heavy metals in soils of industrial areas and arsenic in soils mainly in the Ganges Floodplains may cause reduction in crop yields as well as long term risks to ecosystems and humans health. Intensive cropping with modern crop varieties and use of less or no organic manures and crop residues results in decreased soil organic carbon and plant nutrients leading to severe land degradation. Applications of different organic materials transform into stable forms of carbon with high adsorption sites which might help heavy metal adsorption and organo-mineral complexation and ultimately helps in environmental amelioration. It is hypothesized that resource conservation technologies comprising soil and crop management practices (minimum tillage, vermi-compost, tricho-compost, poultry manure, household wastes, organic fertilizers, crop residues, biochar etc.) can improve soil resilience and increase its productive capacity in the climate vulnerable and polluted areas and therefore studies are needed in these issues. The sub-project is being coordinated by BARC; and BARI, BRRI, BINA, BAU, BSMRAU and SAU are working as the implementing organizations.

Progress: The project is being coordinated by BARC; and BARI, BRRI, BINA, BAU, BSMRAU and SAU are working as the implementing organizations. Annual Review workshop of the project was conducted on 26 June, 2019. Baseline survey on fertility status of 12 selected problem soil areas by all components were completed. Chemical composition of biochar is shown in the following table.

Table 3.24: Chemical compositions of the biochar samples produced from the straws of maize, wheat, groundnut, chickpea, mustard and rice

Amendment	Maize	Wheat	Groundnut	Chickpea	Mustard	Rice	
pH	9.0	9.7	8.2	8.4	9.1	10.2	
OC (%)	48.5	39.5	39.5	48.9	45.5	43.2	
OM (%)	83.96	68.34	68.25	84.60	78.72	74.79	
Total N (%)	2.27	1.91	2.60	2.73	1.54	1.89	
Cation (%)							
Ca ⁺⁺	2.91	2.70	3.02	3.56	3.07	2.17	
Mg ⁺⁺	1.48	1.47	2.00	1.81	1.98	1.43	
K ⁺	1.61	3.14	1.84	3.16	1.06	0.81	
Available P (%)	0.24	0.78	0.54	0.65	0.47	0.33	
Available S (%)	0.17	0.5	0.34	0.29	0.64	0.14	
Metal Ion (%)	Cu	0.014	0.012	0.023	0.014	0.011	0.016
	Fe	0.170	0.064	0.275	0.188	0.062	0.063
	Mn	0.074	0.026	0.166	0.082	0.037	0.027
	Zn	0.017	0.011	0.032	0.017	0.072	0.019

BARI Component: Conducted experiment on “Comparative Performance of Organic material and Dolomite for correction of soil acidity” on cauliflower and Indian spinach at Vabla, Belabo. Data on cauliflower and Indian spinach have been reported. “Improvement of soil health in unfavorable eco-systems (drought soil) with organic amendments for sustainable crop production” were conducted on mustard and T.Aman at Godaghari, Rajshahi. Data on mustard and T. Aman have been reported. BARRI conducted experiments in the heavy metal contaminated areas at Mirzapur and Pirojali of Gazipur. The soils of the experimental fields were found to have high organic matter and more amorphous and crystalline Fe³⁺ compounds, which might have acted as electron acceptors under submerged condition and resulted more Fe²⁺ toxicity in plants. There were no significant effects of applied biochar and organic fertilizers on paddy yield.

Table 3.25: Effects of different organic amendment on yield and yield contributing characters of cauliflower at Belaboduring 2019-2020

Treatments	Curd height (cm)	Curd circumference (cm)	No. of leaves/plant	Marketable wt. of individual curd (kg)	Curd Yield (t/ha)	% Increase over T ₁ treatment	% Increase over T ₆ treatment
T ₁ = Control (no fertilizer)	5.89e	18.57d	8.5c	0.223d	9.05d	-	-
T ₂ = PM @ 3 t/ ha+ IPNS based inorganic fertilizer	9.78bc	35.01ab	14.2a	0.612ab	24.68b	172.7	20.6
T ₃ = PM biochar @ 2 t/ha+ IPNS based inorganic fertilizer	10.26ab	37.78ab	13.1a	0.0646ab	26.38ab	191.5	28.9
T ₄ = Rice husk biochar @ 2 t/ha + IPNS based inorganic fertilizer	10.82a	39.52a	15.1a	0.678a	28.23a	211.9	38.0
T ₅ = Dolomite @ 1 t/ha + 100% RF	9.02cd	33.12bc	13.0ab	0.585b	23.62bc	161.0	15.5
T ₆ = 100% RF	8.71d	29.12c	11.4b	0.507c	20.46c	126.1	-
CV (%)	6.19	8.35	11.49	6.70	8.30	-	-

BARRI component: Determination of heavy metal and Plant uptake of heavy metals and polluted water analyses are in progress under the component. Produced biochar from different organic materials by BARI, BARRI, BAU & SAU components were used in the field experiments to observe their effectiveness for amendment of problem soils and improvement of soil health for sustainable crop production under unfavorable eco-systems. Mineralization study of organic materials and assess their effect on carbon sequestration and other soil properties and crop productivity are going on at BARI, BAU, BSMRAU and SAU components. BSMRAU component recorded lowest carbon mineralization in biochar treated soil (18.7%).

BSMRAU component: conducted one mineralization study with saline soils has been almost completed at control condition (laboratory). The rate of N and C mineralization was significantly influenced by the different organic matters. Higher carbon mineralization was found under continuous standing water (CSW) management condition than under field capacity condition during the whole incubation period.



Mineralization Study under field capacity and CSW condition (Laboratory)

SAU component: It Conducted mineralization study of organic materials resulted that Biochar is the most resistant organic amendments among other organic materials and so Biochar can be a most useful organic amendment for carbon sequestration in Bangladesh condition. Quality of biochars and other organic materials and their field application showed that poultry manure biochar may be a potential amendment for improving crop productivity and soil health. It improves soil microbial properties and enzyme activities resulting in higher nutrient content in soils and crop productivity.

41. Project Title: Determination of antimicrobial resistance and residues in livestock and poultry food products and feed in Bangladesh (ID 138)

Coordinator	: Member Director (Livestock), BARC, Farmgate, Dhaka
Implementing organization	: BAU, BLRI, RU, PSTU, CVASU, SAU, HDSTU
General objectives	: Assessment of antimicrobial drug residues in livestock and poultry food products & feed and its mitigation program, and to determine the antimicrobial resistance & associated genes.
Duration	: Jun 2018 to May 2021
Budget	: Tk 3,09,68,710/-

Background: The slogan of Vokta Odhikar Dibash-2016 is “Antibiotics Jukto Khaddo K Na Bolun”. This slogan indicates that people are conscious about food for the presence of antimicrobial drug residues in food chain which may lead to the development of resistance strain of microbial agents. The increasing use of antimicrobials in humans and animals leading to develop resistance to these drugs, therefore many diseases are becoming difficult to treat. The spread of antimicrobial resistance among human cannot be dissociated in presence of resistant microbes with resistance-encoding genes in human, animals, food chain, and environment. The isolation, identification and characterization of microorganisms in different microbial diseases therefore have paramount important to identify resistance genes in microbial agents. To find out the alternatives are crucial important for the production of safe meat and egg. Probiotics and phytobiotics have already been used as alternative sources of antibiotics in the developed counties due to have no residual effects like antibiotics. There is sporadic report to use of low dose antibiotics drugs as growth promoter, containing several antibiotic drugs residues in food products and feed having detrimental effects in human health. In addition, many studies have shown that antibiotics administered to poultry and livestock are poorly absorbed in the gut and usually excreted without metabolism. These residual antibiotics eventually accumulated and enter into human food chain resulting bioaccumulation of drugs residues in human body. As country wise data are not yet to be available in this regards, the sub-project would therefore be definitely acknowledge the status of antimicrobial drugs residue, resistance microorganism and detection of targeted resistance genes that contributes in antibiotic resistance, and its mitigation program would help safe food production in Bangladesh.

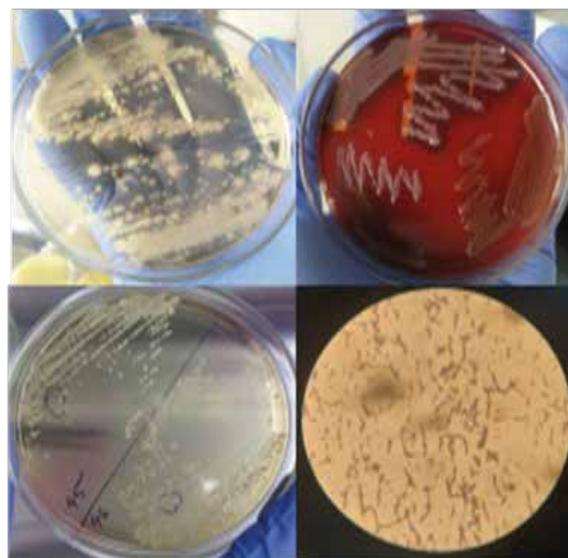
Progress: The sub-project entitled “Determination of Antimicrobial Resistance and Residues in Livestock and Poultry Food Products and Feed in Bangladesh” has been conducting by the eight components namely Bangladesh Agricultural Research Council (Coordination Component), Bangladesh Agricultural University (Component-1), Bangladesh Livestock Research Institute (Component-2), Rajshahi University (Component-3),

Patuakhali Science and Technology University (Component-4), Chittagong Veterinary and Animal Sciences University (Component-5), Sylhet Agricultural University (Component-6) and Haji Danesh Science and Technology University (Component-7). The sub-project has been implementing in the thirty six districts under eight administrative divisions of Bangladesh.

A number of 1312 (86.32%) questionnaire were interviewed among the farmers, veterinarian and feed/drug seller against the target 1520. A number of 2718 (82.86%) samples were collected against the targeted number of sample 3280. A total number of 484 bacterial isolates consisting of six pathogens (*E. coli*, *Salmonella*, *Streptococcus*, *Staphylococcus*, *Pasteurella* and *Corynebacterium*) were recovered from livestock products and by products. Alongside, 742 bacterial isolates consisting of five pathogens (*E. coli*, *Salmonella*, *Staphylococcus*, *Campylobacter* and *Pasteurella*) were recovered from poultry products, by products and feed. The activities were performed by all seven components. An annual review workshop and two training on antimicrobial resistance (AMR) were organized by Coordination Component. Two AMR training were attended by 60 participants held at Sylhet Agricultural University and Rajshahi University respectively. Molecular confirmation of bacterial isolates followed by phenotypic and genotypic characterization of antimicrobial resistance was under progress. The qualitative detection of antibiotic residue in livestock and poultry samples were partially done by two Components (BAU & CVASU) but the results were not compiled. Similarly, for the development of alternatives to antibiotics the laboratory experiments of phytobiotic, probiotics, and spirulina in broiler and layer poultry were conducted by Component-1 (BAU) but the results were not assembled.



Data collection from the field



Streptococcus spp and Staphylococcus spp in selective bacterial media

42. Project Title: Preparedness for the control of PPR in Bangladesh (ID 139)

Coordinator : Member Director (Livestock), BARC, Farmgate, Dhaka
Implementing organization : BLRI, BAU
General objectives : Increase availability of safe and high quality livestock protein through controlling PPR in Bangladesh to meet global control strategy.

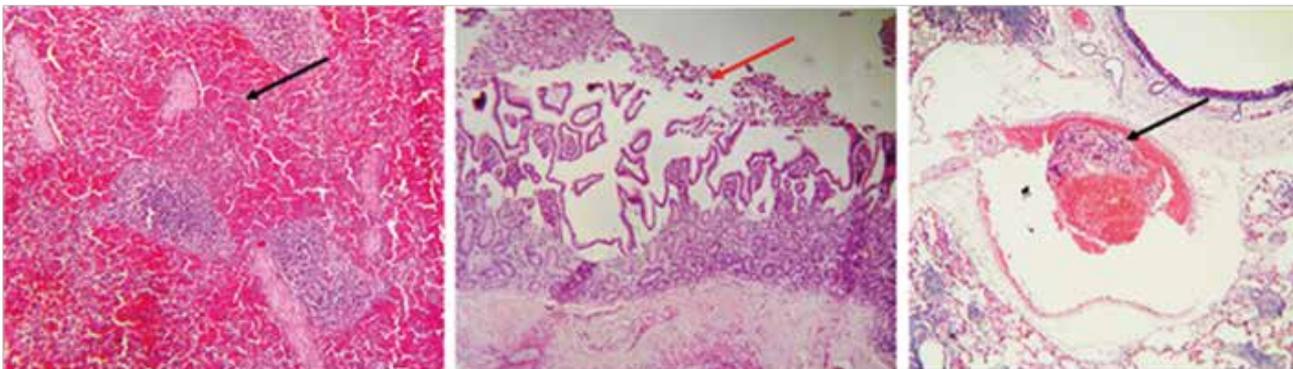
Duration : Mar 2018 to Jun 2021

Budget : Tk 1,81,27,532/-

Background: Peste des Petits Ruminants (PPR) is popularly known as goat/ sheep plague, an important OIE listed trans-boundary animal disease (TAD) of small ruminants in Bangladesh. PPR in small ruminant causes much devastation in village farmers due to high morbidity (10-100%), high mortality (up to 100%) and heavy production losses (due to death of infected goats). In Bangladesh, PPR was first detected in 1993 in Meherpur District. Since then, the disease has spread all over the country resulting in severe socioeconomic consequences (Chowdhury et al., 2014). The eradication plan of PPR from Bangladesh is yet to start as effective way and it needs massive investigation and activities. There are limited studies onto the epidemiology of PPR in Bangladesh (Siddiqui et al., 2014). The epidemiological investigation is needed to develop a progressive preventive/control strategy. A progressive control strategy using intensive surveillance and mass vaccination program over 10±05 years may ensure the attainment. Regular and routine immunization against PPR viruses may generate immune population of small ruminants in Bangladesh, which is necessary to block the transmission cycle of the virus. This intervention will contribute to increased household income, food and nutritional security, women empowerment and significantly reduce poverty which will contribute toward achieving MDGs. The proposed sub-project comprises nationwide Sero-survey, disease surveillance and outbreak investigation for epidemiological information's, development of PPR free zone with locally produced vaccine, development of biologics and socioeconomic studies. Above studies and outputs will give solid foundation to formulate disease control plan in Bangladesh.

Progress: The PPR disease needs regular sero-monitoring and immunization with an effective viral vaccine for its control. Commercially available diagnostics are much expensive and there are controversies about the effectiveness of the vaccine used in Bangladesh. This study is designed to conduct epidemiological study of PPR in goats and other small ruminants in the country, to develop suitable diagnostics for PPR virus and to develop an effective vaccine against PPR using local isolates presently circulating in the country. The sub-project has two components, one at BLRI and the other at BAU with the BARC as a coordinating agent.

BLRI Component showed that only about 46% of the goats from unvaccinated herds have antibody against PPR indicating that the goat population in Bangladesh are at risk of contracting the disease. On the other hand, vaccination of goats using locally produced PPR vaccine was found to improve herd immunity level to an average of 83.33% (81.89-85.72%) indicating that the PPR vaccine produced locally is good enough to protect goats from PPR. The detection rate of RT-PCR for PPR virus was reported by BLRI Component to be around 60% (Out of 287 nasal swabs collected from the suspected PPR outbreak areas 172 were positive for PPR). Phylogenetic analysis, conducted by BAU, of partial N gene of the six selected PPRV samples showed that



Histopathological investigation of spleen (left), intestine (middle) and lungs (right)

the isolated virus has 95-98% homology with viruses circulating in India and China however; the recently isolated PPRV has been found to make a separate sub-cluster indicating evolution at small extent. Towards the development of vaccine seed, out of 36 passages needed for adaptation and attenuation of the virus, 5 passages of PPRV have been completed so far in Vero cell culture.

43. Project Title: Transformation of agriculture for food security and poverty reduction (Project ID: 151)

Coordinator : Chief Scientific Officer (CSO), BWMRI, Nashipur, Dinajpur, Mobile: 01713516217

Implementing organization : BAU and Prottasha Foundation

General objectives : To analyze the nature and extent of agricultural transformation; to identify the drivers of changes in agricultural transformation and livelihood pattern /status; to estimate the effect of agricultural transformation on food security and poverty reduction and to find out the emerging opportunities and challenges for Bangladesh agriculture in the course of transformation

Duration : Sep 2019 to Jun 2021

Budget : Tk 19500000/-

Background: The pervasiveness of poverty and the high population density in Bangladesh make land issues very significant for economic growth and poverty reduction. Access to land is crucial in reducing poverty because it allows poor farm households to make productive use of family labour, to smooth consumption and to improve their income and well-being. The present land utilization systems serve as the prime generators of income and employment in rural Bangladesh (APO, 2003). On the other hand, transformation of agricultural land is due to below-optimum use of agricultural land, poorly constructed road networks, improper land utilization, government land acquisition, brick making, gas station, rural settlements, riverbank erosion and water-logging, etc. (Islam, 2011).

The areas to be taken under the present study are mainly famous for transformation of agriculture cropland into maize cultivation, mango & litchi orchard, flower and HYV rice cultivation. About 80% of the people were directly or indirectly dependent on crop based agro-economy twenty years ago, but now their lives primarily dependent on shrimp culture, maize cultivation, mango & litchi orchard, fish culture and poultry rearing related activities. Weather and congenial atmosphere in the study area is very much suitable for selected (maize cultivation, mango & litchi orchard, Flower, HYV rice cultivation) enterprises. On the other hand, it is very much profitable than other crops. Farmers do not get long time profit from growing different crops. But it is possible to get return for several years from the selected enterprises. It requires low cost of production and the practices seem to environment friendly farming activity. Farmers are somehow motivated by their neighbours those have brought more cropland under mango cultivation. As a result, transformation of cropland into mainly from field crops to mango orchard & litchi orchard, maize cultivation, from local rice to HYV & hybrid rice occurs gradually in the study area. This situation is very much important to the people of the study area because they think that transformation can be helpful for poverty reduction, maintain balance ecosystem and finally achieve the household food security.

The research will help to identify the crucial points that, why land is being transformed day by day and the possible contributions of it, which will ultimately help in proper utilization of land, as well as to improve the economy of the country. In view of foregoing study, the investigators undertake a study entitled "Transformation of Agriculture for Food Security and Poverty Reduction in selected areas of Bangladesh".

This study will hopefully answer to the following research questions.

- What is the present situation of transformation of cropland from field crops to mango & litchi orchard, hybrid maize cultivation, flower cultivation, local rice varieties to HYV rice cultivation?
- What are the reasons behind transformation of cropland from field crops to mango & litchi orchard, hybrid maize cultivation, flower cultivation, local rice varieties to HYV rice cultivation?
- What are the effects of transformation of cropland from field crops to mango & litchi orchard, hybrid maize cultivation, flower cultivation, local rice varieties to HYV rice cultivation?
- What are the challenges faced by the farmers during transformation of the cropland the use of other non-crop sectors?

Progress: The transformation crops under investigation of the study are litchi, HYV maize, flower and mango with respective locations of Dinajpur, Lalmonirhat, Jessore and Chapai Nawabgonj, respectively whereas Narail and Barishal are selected as locations for HYV rice. Five types of checklists have been prepared for Five (5) categories of crop farmers each and six (6) FGDs have already been implemented for the farmer groups in six selected investigation locations. A total of 1314 respondents has been determined comprising 700 farmers who are changing crops land towards others purposes and transforming the common agriculture phenomenon; 24 UAO/AEO, 120 SAAO/SA; local leaders 120 and 350 NGO//Traders personnel. Face-to-face interview; Focus Group Discussion (FGD), Key Informant Interview (KII) and other appropriate tools are being used for collecting primary data. The secondary data are being collected from the researched concerned domestic and international organizations. Some important factors affecting the livelihoods and agricultural transformation in levels of the selected farmer groups such as age, year of schooling, household size, farm size, farming experience, annual family income, training exposure, credit received extension media contact, organizational participation, innovativeness and knowledge on farming have been included in the questionnaires/schedules/checklists for collecting the primary data.

It is worth mentioned that almost all target activities of the study from March to May 2020 have already been held up due to COVID 19 pandemic. In this circumstance, work plan of first year, performed major activities with financial expenditures within the reporting period of 15 October 2019 to 30 June 2020 and work plan for the 2nd half of 1st year 2020 have been mentioned in the report. The target activities in first year as per work plan are mainly recruitment of project personnel; procurement of capital & fixed items; organize inception, baseline survey & program planning, half yearly progress review, filed monitoring report presentation and annual review workshop; conduct desk monitoring, field monitoring & evaluation; collection, entry and analysis of data; provide training to personnel on project activities and publication of research paper. Of these planned works, the activities performed in the reporting period are recruitment of project personnel; selection of study areas; preparation and approval of procurement plan and procurement of capital & fixed items; organizing and implementing inception workshop, compiling and editing proceedings of inception workshop; developing and revision of 5 types questionnaires/scheduleschecklists for litchi HYV maize, flower, mango and HYV rice producers; implementing farmers training and FGDs; performing desk monitoring of activities of BAU and Prottasha Foundation Component; organizing coordination meeting with BAU and Prottasha Foundation Component for developing questionnaires and checklists and advancing other activities of the project.

44. Project Title: Development of protective culture technology for safe and quality vegetables and fruit production (ID 152)

Coordinator : Chief Scientific Officer, Olericulture Division, HRC BARI, Gazipur-1701

Implementing organization : Olericulture Division, HRC, BARI and SAU, Dhaka

General objectives : To develop protective culture technology for high value vegetables and fruits and to produce safe and quality vegetables and fruits for both local and export market.

Duration : September 2019 - June 2021

Budget : Tk.170,00,000/-

Background: Currently, export of fruits and vegetables are considered to be a big source of foreign earning exchange. Farmers are not getting expected market and market price of horticultural crops as its improper production practices, such as excessive use of chemical fertilizers, pesticides, unhygienic pre-and postharvest handling, lack of value addition activities, etc. Therefore, these unsafe produces failed to enter into the quality super market and export markets. Now-a-days, consumers are also ever more concerned about obtaining safe and quality food. In this regards, implementation of protected cultivation would minimize indiscriminate use of fertilizers, pesticides, pre and post-harvest losses. It will also ensure production of safe fruits and vegetables with good nutritional qualities, increase farmer's income and country's economy. Protected cultivation at least is needed to convert some portion of present area under vegetable and fruit cultivation for increasing the national productivity and quality of the produce. Under the new era of WTO (World Trade Organization), these kind of models possess high potential for enhancing the income of farmers opting for quality and offseason vegetable cultivation under protected conditions. This technology has very good potential especially in urban and peri-urban areas adjoining to the major cities which is a fast growing market for fresh produce of the country. But protected cultivation technology requires very careful planning, maintenance and management about timing of production and moreover, harvest time to coincide with the shortage period of availability of vegetables and high market prices, choice of varieties adopted to off season environments, and able to produce higher and economical yields of high quality produce etc. A high value, short duration and small size vegetables and fruits are mostly suitable under protected cultivation. Tomato, brinjal, sweet pepper, cabbage, cauliflower, broccoli, bitter gourd, cucumber, netted melon, watermelon, dragon fruit, strawberry, papaya, banana, guava, lemon are being raised. The protected cultivation of vegetable and fruits is an advantageous technology for farming community because of cost effective technique. Vegetables and fruits grown by this method are safe to consume due to less use of chemicals. This technique also provides congenial environment to off season cultivation as well as high and quality production. Therefore, increasing demand of vegetables and fruits for growing population can be fulfilled by this technology.

Progress: The sub-project is being implemented by the Olericulture Division, HRC, BARI and Department of Horticulture, Sher-e-Bangla Agricultural University (SAU), Dhaka with the view to develop protective culture technology for high value vegetables and fruit to produce safe and quality vegetables and fruit for both local and export market. The sub-project was initiated with an inception workshop held on 16 January 2020. The sub-project is designed with fourteen activities at BARI component and eighteen activities at SAU component. By this time BARI and SAU has completed two research activities each.

BARI component: One experiment titled "Effect of different shade house on seedling raising of high value (HV) vegetables" was conducted with the seedlings of Tomato, Brinjal, Capsicum, Broccoli, Netted melon, Cucumber and the four poly house treatments were a) UV stabilized polyethylene film + Insect net (60 mesh) + Green shade net; b) UV stabilized polyethylene film + Insect net (60 mesh); c) Insect net (60 mesh) and d) Control (Open field). The good quality and vigorous seedlings were produced by the treatment- UV stabilized polyethylene film + Insect net (60 mesh) followed by UV stabilized polyethylene film + Insect net (60 mesh) + Green shade net and Insect net (60 mesh), while inferior seedling were produced by Control (Open field). Another experiment titled "Effect of different mulching paper on growth and field performances of HV vegetables in different shade house" was conducted with the vegetables of Tomato, Brinjal, Capsicum, Broccoli, Netted melon, Cucumber and three mulch treatments were a) Bi-colour mulch paper; b) Black mulch paper; and c) Control (No mulch). The higher yield was produced by the treatment 'Bi-colour mulch paper' in all vegetables, followed by 'Black mulch paper' and lowest yield was produced by control plot (no mulch).



Seedling growing in UV stabilized polyethylene film + Insect net (60 mesh)

SAU component: One experiment titled "Effect of maleic hydrazide and potassium foliar spray on sex expression, yield and quality enhancement of muskmelon" was conducted. Results showed that maleic hydrazide played a significant role in regulating vegetative characters, sex expression, and number of fruit per plant and content of β -carotene in harvested fruits. On the other hand, foliar application of potassium improved the fruit size, total soluble solid, ascorbic acid and reducing sugar and decreased total acidity in fruits. Based on the results, it may be suggested that growing muskmelon by spraying maleic hydrazide is suitable for sex expression and higher fruit yield while foliar spray of potassium presented better quality fruits. Therefore, the sprays of maleic hydrazide and potassium solution in plants presented significantly superior effects on growth, sex expression, yield and quality attributes of muskmelon. Another experiment on "Effect of different shade houses on growth, yield and quality attributes of strawberry" was also conducted under different shade houses.



Strawberry grown in UV poly house

Results revealed that among the shade houses, fruits grown under UV poly shade had more total soluble solid, titratable acidity, ascorbic acid and lower pH. Fruits grown under poly shade had more reducing sugar and total phenol. However, yield and yield contributing parameters of the strawberry were higher in net house. Based on the results, it may be suggested that growing strawberry under net house was the most suitable growing conditions for yield and yield contributing parameters while strawberry produced in UV poly shade and poly shade presented better quality fruits.

Moreover, three experiments (Effect of different shade net on growth and quality of HV vegetables, Effect of different net on the incidence of insect and diseases on different HV vegetables and Determination of optimum maturity stage of selected HV vegetables under shade net) of BARI and one experiment of SAU (Effect of different mulch materials on the growth, quality and yield of strawberry) are ongoing. Concern data are being recorded. But due to COVID -19, there is a problem for recording data in proper time and creating some disturbance of crop management and crop protection.

45. Project Title: Development of production package for horticultural crops in rooftop and open space in urban areas of Bangladesh (ID 153)

Coordinator : Director, Horticulture Research Center (HRC), BARI, Gazipur

Implementing organization : HRC, BARI; SU, Dhaka

General objectives : to develop production package for different flower and ornamentals; to standardize rooftop gardening for horticultural crops in urban areas ; to popularize different horticultural crop varieties under hydroponic culture and also for commercial field trial

Duration : Oct 2019 to Jun 2021

Budget : Tk 21500000/-

Background: Ensuring a space for gardening in the urban areas is difficult but rooftop is the only open space having more sunlight for gardening. Rooftop gardening assists in reducing overall heat absorption of the building as well as minimizing energy consumption. It may help to ensure better quality of life by supplying chemical free horticultural crops. It may also be a good scope to grow rare and unavailable vegetables, fruits and flowers. Pollution can also be reduced through maintaining the greenery. Rooftop garden is a source of Carbon sink; it helps to ensure cool environment and the habitat of biodiversity. Recent research findings showed that top floor's temperature of a building may go down upto 2-30C for cultivating different horticultural crops on rooftop. It also helps to provide mental recreation for the residents and increases the beauty of the building (Chowdhury, 2014). It can be mentioned here that the city corporation authority of agriculture friendly government has declared 10% holding tax exemption for promoting rooftop gardening in Dhaka city. Through this process, one can use maximum space to cultivate diversified plants by using the containers of tub, nylon net, medium size drum, iron or steel frame, plastic pot and water proofed rod. Farming on the rooftop of the buildings in urban areas is usually done by using green roof, hydroponics, organic, aeroponics or container gardens (Asad and Roy, 2014). The first benefit of this practice is increased by local supply of fresh food and beautification. Different kinds of potting containers and soil media are being used by the gardener for growing different types of vegetables, fruits and flowers due to unavailability of

package of technologies. If the rooftop gardener can use the roof top in a planned way like following a model with maximum number of vegetables, fruits and flowers in a small area and use appropriate soil media in appropriate pot/tub, the rooftop garden will not only be an attractive place for recreation but also will be a source of maximum amount of fresh horticultural products. But fact is that, there are no systematic research findings or even package of information related to rooftop gardening of horticultural crops. As a matter of fact, it is necessary to investigate and standardize different issues on rooftop gardening in context of Bangladesh. Therefore, the project has been proposed to develop a package of flower production as well as rooftop gardening techniques covering horticultural crops in urban areas of Bangladesh.

Progress:

BARI (Floriculture division) component: Under the sub-project seven experiments are being conducted: i) Effect of pinching and boron on quality flower production of carnation, ii) Effect of plant growth regulators on growth and flowering of chrysanthemum, iii) Effect of potting media on growth, yield and quality in aglaonema, iv) Effect of substrates on yield and quality of anthurium in soilless culture, v) Effect of different potting media on ground orchid, vi) Adaptive trial of different varieties of gladiolus, gypsophila, liliuand marigold at farmer's field and vii) Soilless culture of selected vegetable crops. The findings of the experiments are summarized below:

The findings of the 1st experiment revealed that double pinching with boron @ 0.1% accelerated the vegetative, flowering, yield and quality characteristics of carnation. On the other hand, foliar application of 100 ppm GA3 was the best for obtaining better growth of plants, maximum number of cut blooms with longer stalk as well as bigger flower size with prolonged vase life was obtained in chrysanthemum. Results of 3rd experiment indicated that proportion of potting media viz. Cocodust + perlite +vermicompost (1:1:1) could be used for maximizing plant growth and quality of Aglaeonema. Among the various substrates, cocodust and perlite at the ratio of 1:1 performed the best in respect of growth, floral and quality characteristics of Anthurium. Among the potting media, Coconut husk chips + Spahagnam moss+ Vermicompost + Farmyard manure (1: 1:1:1) showed the best result with respect to growth, yield, vase life and longevity of spike on plant of ground orchid. Adaptive trial of different varieties of gladiolus, gypsophila, tuberose, liliu and marigold at farmer's field at Gazipur, Jamalpur, Rangpur, Rajshahi, Khagrachori and Bogura indicated that BARI Gladiolus-3, BARI Gladiolus-4 and BARI Gladiolus-5 showed better performance and produced higher yield at all locations. The demand of BARI Gladiolus-3 and BARI Gladiolus-4 were more in Jamalpur, Rajshahi and Khagrachori due to consumer's choice, economic value and early flowering habit of those varieties. On the other hand the demand of BARI Gladiolus-3 and BARI Gladiolus-5 were more in Gazipur, Bogura and Rangpur. BARI Tuberose-1, BARI Gypsophila-1, BARI Liliu-2 and BARI Marigold-1 variety showed better performance and produced higher yield over local variety in all the locations. Soilless culture of tomato and cucumber on different substrates showed that tomato and cucumber were performed better in cocodust and vermicompost at the ratio of 2:1.



Production of Anthurium in soilless culture

SAU component: Horticulture Department of SAU has six activities but SAU component could not able to complete any of the experiments. It may be mentioned here that one experiment is under in field condition and another two will be started very soon. Influence of organic amendments and bio-control agent on the production of quality flower production of gerbera is now in under field. Necessary data are being collected.

BARI (Pomology Division) component: Among the five experiments viz., 1) Development of production package of some selected fruit crops for rooftop gardening, 2) Effect of different growing media for dragon

fruit production on the roof and 3) Adaptive trial of selected fruit crops at farmer's field are being conducted. Results of experiment 1 showed that Shahi pepe performed better than Top lady for both vegetative and yield contributing characteristics with large tub (100L) on the roof. In case of lemon, BARI lebu- 1 performed the best among other varieties. For pumelo production in roof top garden, BARI Batabilebu-6 performed very well in vegetative characteristic's (plant height, stem diameter, number of leaves, number of branches, canopy spread and leaf area) whereas local variety of pummelo did not perform well. In case of guava, BARI Peyara-4 performed well in vegetative characteristics but for yield contributing characteristics BARI Peyara-2 performed better. As for rooftop gardening BARI Amra-1 performed well. In case of Carambola, BARI Kamranga-1 showed the better performance in vegetative characteristic's compared to the local variety. Performance of BARI Dragonfol-1 was better than BAU Dragonfol-1 in respect of growth characteristics.



Production of quality flower using organic amendments

In experiment 2, two types of media were used (soil and soilless). In soil media (set-1) there were 6 treatments viz. T1 = 100 % loam soil; T2 = 100 % coco dust; T3 = 100 % biochar; T4 = 50 % loam soil + 50 % coco dust; T5 = 50 % loam soil + 50 % biochar; T6 = 50 % coco dust + 50 % biochar. In Set-2: (Soilless media), there were 3 treatment s viz. T1 = 100 % Coco dust; T2 = 100 % Biochar and T3 = 50 % coco dust + 50 % Biochar. For set-1, the tallest plant was found in T4 treatment whereas, the highest number of branches was recorded from T5 treatment.



Fruit production on roof top

In case of soilless media, the highest plant height and the number of branches found in T3 treatment followed by T1 and T2 treatment. Adaptive trial of BARI Dragonfol-1 and BARI Peyara-4 has already been planted in the farmer's field and their growth is so satisfactory. The adaptive trial (field trial) has already been setup in two Upazilas (Nalitabari and Jhenaigati) of Sherpur district. All other experiments are being conducted on the rooftop of HRC, BARI, Joydebpur, Gazipur. However, another two experiments titled "Evaluation of strawberry production in different growing methods on the roof" and "Rooftop gardening: A sustainable technology for quality and safe fruit production and consumption" will be conducted during winter 2020-2021.

46. Project Title: Sustainable development of indigenous fisheries in baors of south-western Bangladesh through multiple-functions for ensuring the food security (ID 154)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka, Mobile: 01777686866

Implementing organization : RU and JUST

General objectives : To assess and enhance the stock status in Baors of Southwestern Bangladesh by identifying the threats

Duration : Oct 2019 to Jun 2021

Budget : Tk 2,40,00,000/-

Background: Baors are oxbow lakes, formed by dead arms of rivers, are situated in the moribund delta of the Ganges in western part of the country. Baors (Oxbow lakes) are generally represented as old course of rivers and formation it has been cut off from the main river through a series of time. In Bangladesh, baors or oxbow lakes are one of the important inland water resources, which are created due to the changed course of the rivers. There are more than 600 baors in south-western Bangladesh, covering an area of 5,488 ha, each ranging from 10 to 500 ha, mostly situated in three greater districts of Jashore, Kustia and Faridpur having many of these concentrations in greater Jashore district. At present, there are 37 large oxbow lakes and 50 small baors are located in south western of Bangladesh, which covers a total area around 5488 ha and produces 6146 mt fish (FRSS, 2014). The baor fisheries are highly important because they serve as the breeding ground for small indigenous fish species. Generally the water depth of baor is higher than the beels. However, currently most of the Baors have already lost its fashionable characteristics due to natural as well as human intervention. Due to over exploitation of fish including use of harmful fishing gears and system (fishing by dewatering), degradation and loss of fish habitats, increase agriculture production and road communication, siltation of water bodies by natural process, introduction of a number of alien fish species and water pollution by industry and agrochemicals, the natural inland fish stocks have declined significantly and fish biodiversity have been affected seriously (Ali et al., 2009). Also, due to competition and intervention of aquaculture (e.g., use of fertilizers and feeds) small indigenous fish species including *Channasp.*, *Puntiusp.*, *Mastacembelus* sp., *Mystus* sp. and *Colisafasciatus* have been locally extinct or threatened in the baor. Moreover, man-made causes together with climate change are responsible for degradation of the baor fisheries.

Progress: To enhance the indigenous fish production and upgrade the livelihoods of fishers' community through sustainable management of Baors fisheries of Bangladesh, the present research under the sub-project is implementing by the University of Rajshahi (component 1) in the Baors of Jhenidah district and by the Jassore Science and Technology University (component 2) in the Baors of Jashore district.

RU component: The component is being collected monthly fish samples using traditional fishing gears by the hired fishing boats and fishers. Length-weight and gonadal data for each individual of every species is being collected in the laboratory. Also fish gonad is used to calculate gonadosomatic index (GSI %) for the estimation of actual size at sexual maturity and spawning- and peak-spawning season of small indigenous fishes in Baors. Information on fishers, different types of traps, causes of Baor fishery reduction, declining of catches/production has been collected through survey, questionnaire and Focus Group Discussion (FGD) from local fisherman group, fish farmers, Government and NGO personnel. Statistical analyses is being done with consideration of 5% significant level. Fish sanctuary has been established for facilitating fish spawning and conservation. About 18 indigenous species from sarjat baor, 3 from sagana baor, 6 from Fatehpur baor, 1 from Kapashaia baor, 2 from porapara baor, 3 from Katgora baor had been extincted. Those species extincted before 15 to 20 years ago except saganna baor. The reason behind extinction were little rainfall, introduction of aquaculture in baors, application of pesticide in



Fishing and available fish species in Saganna baor

agriculture field near baors etc. Selected indigenous fishes has been stocked after marking and tagging to observe the changes of relative abundance by Catch per unit effort and reproductive potentiality through gonadal studies. About 8 indigenous species including *Anabas testudineus*, *Channa punctatas*, *Clarius batrachus*, *Heteropneustes fossilis*, *Mystus tengra*, *M. vitatus*, *M. cavasius* and *Ompok pabda*. Mean body length was varied from 6 - 26 cm while body weight 4.7-151 g for individual speies. Number of stocking fish was 700 - 3930 for different species. Finally, these finding would be useful forlong term sustainable management policy of small indigenous fish species in the Baors of southwestern Bangladesh.

JUST compnent: The component has selected indigenous fishes and stocked after marking and tagging to observe the changes of relative abundance by catch per unit effort and reproductive potentiality through gonadal studies. Fish sanctuary was established for facilitating fish spawning and conservation. Monthly fish samples are being collected using traditional fishing gears by the hired fishing boats and fishers. After that, morphometric and meristic data and gonadal data for each individual of each species are being collected in the laboratory. Also fish gonad is used to calculate gonadosomatic index (GSI %) for the estimation of actual size at sexual maturity and spawning- and peak-spawning season of small indigenous fishes in Baors. Statistical analyses has done with consideration of 5% significant level. However, the proposed project is going to deal with the enhancement of production of indigenous fishes through multi model inferences. Finally, these finding would be useful fortheir long term sustainable management policy of small indigenous fish species in the Baors of southwestern Bangladesh.



Fishes are restocking in Bukvora baor

47. Project Title: Exploration of exogenous enzymes, bivalent efficacy and Omega-3 fatty acid of microbes and small invertebrates as potential feed supplement for enhancing fish and shrimp productivity (ID 155)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka, Mobile: 01777686866

Implementing organization : BSMRAU, NSTU, SRS, BFRI

General objectives : Development of technology for reducing fish/shrimp mortality by improve feed digestibility and disease resistance.

Duration : Jun 2019 to Jun 2021

Budget : Tk 2,80,40,000/-

Background: The expansion of global aquaculture production is increasing the demand for aquaculture feeds. Fishmeal is the main and most critical ingredient in aqua-feed production. The increasing cost of fishmeal has

encouraged feed manufacturers search for cheaper alternative protein sources such as plant proteins. However, feed ingredients from plants sources contain some compounds that either the shrimp/fish cannot digest or which hinder its digestive system because they cannot produce the require enzymes to degrade. Considering these problems, scientists are now searching different target oriented exoenzymes from microbial sources which can eliminate the major problems for plant-based aqua feed materials. Supplementation with enzymes can help to eliminate the effects of anti-nutritional factors and improve the utilization of dietary energy and amino acids, resulting in improved performance of fish/shrimps. Production of exoenzymes through microbial fermentation has already been started in many different countries including USA, UK, Europe and Asia. Feeding enzymes to shrimps and fishes is one of the major nutritional advances in the aquaculture sector since last few years. But efficacy of those exoenzyme depends on the sources of microbes, type of microbes, other properties of enzymes such as temperature stability, pH stability etc. So, researches on their isolation, characterization of properties, production on bench-scale to pilot-scale and their application in aquaculture industry is of prime importance. Therefore, this proposed research is designed with a view to search and identify the suitable indigenous microorganisms for isolating exoenzymes to sustain the commercial aquaculture.

Polychaetes under Nereidid commonly named as Omega-worms due to their high content of omega-3 (w-3) polyunsaturated fatty acids are valued by the aquaculture industry as an excellent source of PUFAs, and they have the potential to supplement fish oil as sources of essential lipid components of feeds. It is clear that Nereidid worms no doubt by contributing high content of Omega-3 fatty acids has overwhelming effects on life's health condition from aquatic organisms to public health. Therefore, with the dramatic increase in the capacity for biological screening and chemical synthesis, there is a colossal demand for large quantities of early information on, distribution, identification, fatty acid content and culture method of coastal and/marine polychaetes are very necessary in Bangladesh and the present study has been designed.

There is growing interest in the use of beneficial bacteria, probiotics, as an alternative strategy to antimicrobial compounds for disease prevention and control in aquaculture. These naturally occurring bacteria exert their beneficial effects on the host by modifying the microbial community associated with the host, by ensuring improved use of the feed or enhancing its nutritional value, or by enhancing the host response towards disease. Beneficial bacteria improve the growth and survival of fish and shrimp by modifying the host-associated or ambient microbial community.

Progress:

BSMRAU component: collected soil samples from different selected areas like Cox'sbazar, Nagoan and fermented bamboo shoot was collected from Bundarban. A total twenty bacteria were isolated and purified through different media based isolation and differentiated among the colonies using colony morphology and biochemical characterization. Initially pure isolated colonies were screened for identifying the cellulase (cellulose degrading enzymes) using Congo-Red media based method. Colonies showing discoloration of Congo-Red were taken as positive cellulose-degrading



Cellulose degrading bacterial colonies

bacterial colonies and used for further analysis like biochemical characterization and enzyme determination assays. Following screening, different biochemical characterization such as gram test, catalase, TSI test, starch hydrolysis test, gelatin test, citrate test and hemolytic test and identified as potent cellulose degrading enzyme producing colonies. Enzyme production and quantification with its characterization is on-going.

NSTU Component: considering its set objectives, since the inception, the NSTU component completed project staff recruitment, approval of procurement plan, benchmark survey. Malancha River, Satkhira range (Sundarbans) and Bakh Khali River, Moheskhal Channel, Cox's Bazar have been selected for sample collection in the coastal and marine waters respectively. As polychaeta species are supposed to abundant at these areas that's why, the first long term field sampling were performed in the greater Malancha river of the Sundarbans aiming to collect polychaeta species and analysis of omega 3 fatty acid contents of some selected specimens as well as to check the feasibility of some species of polychaeta culture techniques. The project team members set out to Munshiganj office for sampling on March 15, 2020. Preliminarily discussion with the forest authorities and the local people made about the suitability of the sampling and leasing culture ponds from the local farmers and landlords. Four sampling stations were primarily selected for polychaeta collection. After Collecting samples of polychaetes were kept in 6 inch sand layer tray to observe the survival capacity and possible field identification of the collected polychaete. All the collected samples were brought to the Department of Fisheries and Marine Science laboratory for further analysis.



Polychaeta sample collection at local Chunkuni River

BFRI component: Within the reporting period the component partially completed its baseline survey in Bagerhat region to know that how many farmers use probiotics for shrimp culture through questionnaire survey. According to the survey, 20 % farmers use probiotics for shrimp culture. For Construction of recombinant Plasmid containing WSSV protein (Selection of Target protein cloning into Expression Vector). WSSV VP28 protein was selected as target protein cloning into expression vector. Primer for WSSV VP28 was designed. Xba1 and Xma1 restriction site were selected to clone into desired expression vector pHT43 so far. Laboratory equipment have been arranged for the construction. For the Experiment Phases (Phase 1; Determination of monovalent efficacy of Bacillus spp as probiotic candidate; 2: Determination of monovalent efficacy of Bacillus spp as probiotic candidate; 3: Determination of efficacy of Bacillus spp on growth and survival of P. monodon) necessary supportive lab equipments are still to procure which under process.



Inception workshop of BFRI component

48. Project Title: Stock assessment of commercially important fishes in the bay of bengal through multi-model inferences and molecular markers: management policy implications considering the emerging climate change (ID 156)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka, Mobile: 01777686866

Implementing organization : RU and SAU (Dhaka)

General objectives : To determine and categorize the stock of commercial fish species of the Bay of Bengal to ensure maximum sustainable yield for assisting the livelihood of highest number of fishers.

Duration : Jun 2019 to Jun 2021

Budget : Tk 3,30,00,000/-

Background: Catch or production from open-water capture fisheries have been declined abruptly in Bangladesh due to the environmental degradation, climate change and numerous anthropogenic activities such as indiscriminate catching of juveniles, killing of spawners during peak spawning season, pollution from various sources, constructions of barrage and dams, siltation etc. While in last few years, the catch of marine fishes has been increased progressively, indicating a viable alternative for more fish production. The Bay of Bengal (BoB), the marine area of Bangladesh, is characterized by a semi-enclosed tropical basin. The BoB is one of the world's 64 Large Marine Ecosystems (LMEs). The entire shelf area of Bangladesh (up to 200 m depth contour) covers about 70,000 km². Marine fisheries production contributes 16.18% of the national fish production (DoF, 2016). The BoB is very rich in fish and shrimp species biodiversity. Around 511 marine species, together with shrimps, exist within Bangladeshi waters. There are about 100 important species of which 20 fish families are highly commercial, contributing about 82-87% of the total demersal exploitation in Bangladesh. About 36 species of shrimps have been recorded from the marine water of Bangladesh.

In order to manage the commercially important fishes effectively, it is necessary to identify the exact reason for declining in relation to its life history traits, i.e., populations parameters, stock status. For sustainable exploitation, conservation and management of the renewable marine resources, investigations on the spawning seasons of commercially important marine fishes in the Bay of Bengal (Bangladesh) is greatest important for the country. Besides, the proposed project will also recognize the limitations of fisheries management at the unit stocks level and establish sustainable conservation and management policy for commercially important fishes effectively in the Bay of Bengal. Finally, the proposed research is going to deal with the rapid assessment of fisheries stocks by species in recently resolved waters of EEZ of Bangladesh. Therefore, this study covers the strategies of Marine Fisheries and Exploring Blue Economy for the first priority of Fisheries Sub-Sector of 7th FYP in Bangladesh with aiming to achieve the SDGs.

Progress:

RU component: has been collecting monthly fish samples from the selected marine locations using traditional fishing gears by the hired fishing boats and fishers from different site (Pathorghata, Barguna; Alipur, Potuakhali; Chattogram and Cox's Bazaar). Since last six months, in the laboratory, length-weight data, and gonadal data for each individual of 15 commercially important fishes were collected. Sexual maturity was estimated based on maximum length of 15 commercially important fishes using samples from Mid-October 2019 to Mid April 2020. Condition factors and form factor were estimated of 15 commercially important

fishes using samples from Mid-October 2019 to Mid April 2020. A total of 168 commercially important fish species were observed from the Bay of Bengal since last six months in the commercial and hired fishers' catches of the landing centers. Among them, 15 commercially important fishes were used for analysis. This study illustrated the minimum and maximum length and weight of 15 species found in the Bay of Bengal. Highest number of individuals was found in 10.00-30.00 cm TL length class. Additionally, the observed length showed that about 50% of the number of species present in the Bay of Bengal was smaller than 30.0 cm TL. Population structure showed that, minimum and maximum length for different fishes obtained from the Bay of Bengal were 67.5-99.5 cm for *L. calcarifer*, 10.5-26.9 cm for *P. heterolepis*, 13.5-38.0 cm for *P. chinensis*, 23.0-68.0 cm for *E. affinis*, 11.10-29.8 cm for *S. taty*, 11.5-38.0 cm for *S. panijus*, 11.5-22.0 cm for *P. paradiseus*, 15.0-37.0 cm for *M. cordyla*, 13.5-27.0 cm for *H. nehereus*, 10.80-21.0 cm for *C. dussumieri*, 10.0-22.0 cm for *T. setirostris*, 14.0-28.0 cm for *A. chacunda*, 11.0-45.0 cm for *I. megaloptera*, 12.30-49.0 cm for *P. macracanthus*, and 13.9-21.0 cm for *A. leiogaster*. During this project, growth pattern was determined from the calculation of length weight relationship. From these calculation, negative allometric growth were found for *P. heterolepis* ($b = 2.79$), *P. chinensis* ($b=2.60$), *S. taty* ($b=2.96$), *P. paradiseus* ($b=2.31$), *M. cordyla* ($b = 2.93$), *H. nehereus* ($b=2.66$), *T. setirostris* ($b=2.73$), *A. chacunda* ($b=2.33$), *I. megaloptera* ($b=2.91$), *P. macracanthus* ($b=2.52$), *A. leiogaster* ($b=2.40$). Additionally, positive allometric growth were found for *L. calcarifer* ($b=3.29$), *E. affinis* ($b =3.02$), *S. panijus* ($b=3.62$), *C. dussumieri* ($b =3.71$). Data on fishers, declining of catches/ production are going on through survey, Focus Group Discussion (FGD) and survey local fish market to identify the major causes for declining the fishes in the Bay of Bengal.



Marine fish species at landing center

SAU component: During the reporting period Fish samples were collected from different site (Pathorghata, Barguna; Alipur, Potuakhali; Chattogram and Cox's bazar by the component 2 (SbAU) of the sub project. Then, genomic DNA was extracted from fin and tissue samples of the fish. COI barcoding were used for accurate identification of fish. COI gene sequence were matched with the sequence of same species retrieved from GenBank. Thus the species was confirmed by assessing genetic similarities and distances by NCBI Blast search. A survey was conducted by group discussion (FGD) among fisherman, traders, researchers, GO and NGO personnel to know the major causes for declining the diversity and amount of fishes in the Bay of Bengal. Overfishing, habitat destruction and use of destructive fishing gears and changing of climate pattern were detected for this.



Observation and collection of fish: *Polynemus paradiseus*

49 Project Title: Development of fish-based food products and extension of shelf life to enhance nutritional security (ID 157)

Coordinator : Member Director (Fisheries), BARC, Farmgate, Dhaka, Mobile: 01777686866

Implementing organization : NSTU and RU

General objectives : Development of marketable value-added fishery products and shelf-life extension through MAP packaging and mapping seafood consumption pattern with nutritional status of adolescent girls at different geographical areas of Bangladesh.

Duration : Jun 2019 to Dec 2021

Budget : Tk 2,78,00,000/-

Background: Bangladesh is a riverine country endowed with huge aquatic resources. Fish and fishery products are the major sources of animal origin diets of the people. Despite having huge aquatic resources, malnutrition still exists in Bangladesh where micronutrient deficiencies are the main concern. This so called trash fish (mainly small indigenous fish species) are full of micronutrients and needed to supply adequately throughout the year to the vulnerable people. Ready to eat fish (prepared status of fish and fish products for consumption) based products like fish powder could be a very good option to mitigate many challenges of food and nutritional security of vulnerable population. These products could be an alternative choice to utilize during lean period, as food aid for the crisis population (for instance Rohingya immigrants from Myanmar, Monga; seasonal food crisis affected people in northern Bangladesh). Moreover, incorporating this powder into local cuisine will make it popular in the all segment of the society. However, recently several companies in the country introduced some value-added meat products under frozen condition in the market. On the other hand, with increasing consumer demands for fresh products with extended shelf life and increasing energy costs associated with freezing and frozen storage, the fish-processing industry is actively seeking alternative methods of shelf life preservation and marketability of fresh, refrigerated fish and at the same time economizing on energy costs (Ashieet al. 1996). Therefore, value added products either ready-to-cook (RTC) or ready-to-eat (RTE) fishery products with sufficient shelf-life under refrigerated condition could be introduced in the market. Fish is usually sold as whole or cut without proper storage and displaying facilities. As a result, a considerable amount of raw fishes undergo quality deterioration resulting quantitative loss during retailing (Hossain et al. 2013). However, the retail superstores of the country now sell raw fishes or thawed fishes as whole or sometimes as steaks under refrigeration or icing condition. This chilled storage will not necessarily extend the shelf-life sufficiently for retail distribution and display purposes. However, repeated thawing and freezing is also practices in superstores.



Fish powder

Progress:

NSTU componet: Under the present research with the ultimate goal to develop fish-based value-added and ready to use supplementary food products (RUSFs) to ensure food and nutritional security for different segments of people, the NSTU component has so far developed fish powder from five low-priced species like, Punti, Kachki, Chapila, Sardine, Anchovy those were selected by using a food security index of three major pillars- availability, affordability and nutritional utilization. A standard method was applied to develop fish powder and the quantity and sensory attributes were in satisfactory level. The sensory attributes of gutted samples were found in superior position compared to semi-gutted one. The raw fish and powder ratio was found 6:1 indicates 6 kg raw fish will require producing 1 kg dry fish powder. To understand the nutritional quality, presence of anti-nutritional agents the samples then will send in a competent lab for further screening. At the same time powder from different fish species will send to celebrity chef to prepare wide variety of cuisine. After that, the best quality fish powder as well as excellent cuisine will be selected for RCT (Randomized Control Trail) based on panel test score and nutritional quality. The project work is running within the work design however pandemic covid-19 halt the rest activities since last week of March 2020.

RU component: Under the RU component, to know the consumer's acceptability of MAP packaged fishery products in the superstores of the Dhaka city, site selection for the baseline survey was done. For this purpose, three outlets of major five superstores in Dhaka city namely; Shwapno, Meenabaazar, Agora, Prince Bazar, and Nandan were selected purposively. A structured questionnaire was prepared to investigate the superstore managers on the availability of fishery value added products in the superstores and marketing potentials of those products for consumers. Survey is under process. Training on the laboratory techniques for the laboratory personnel on possible biochemical and microbiological techniques as well sample preparation for packaging and storage has been completed in February-March 2020. The laboratory works was supposed to be started in March 2020. But, it was not started in time due to COVID-19 pandemic situation.

50. Project Title: Analysis of agricultural policy on food system and rural development in Bangladesh: case of haor area (Wetland) management practice (ID 158)

Coordinator : Member Director (AERS), BARC, Dhaka

Implementing organization : BAU, Mymensingh and SAU, Dhaka

General objective : The general objective of the sub-project is to identify policy options for haor area development to filling the gap and generate knowledge base for interventions in rural development, resource conservation and poverty alleviation

Duration : From Sep, 2019 to 30 June 2021

Budget : 1,47,00,000/=

Background: As in other developing countries, an overwhelming large proportion (approximately 40.6%) of the workforce in Bangladesh employed in agriculture/rural sector. A substantial portion of such workforce economically marginalized. The incidence of natural calamities, risk of hazardous events and non-existence of social securities the farmers of main rice producing area around haor/wetland (oxbow lake) are facing high incidence of poverty. These haor areas are the source of livelihoods of 7.8 million of rural people who depend on seasonal fishing, mono crop rice farming, boating, hunting, wage laboring in sand and stone mines, etc. According to the 7th FYP of Bangladesh, priority will be given to address the problem areas like haor that are geographically excluded and ecologically vulnerable. Moreover, the promise in election manifesto by ruling party in 2018 titled “Bangladesh on March towards Prosperity” focuses on 33 sectors to be dealt with two strategic plans - the SDG and Delta Plan 2100. To implement this plan haor/wetland is hotspot for policy development. The sustainable improvement in the living standards of the region can only be brought by capital accumulation, productivity gains and employment and wage increase in this sector. Thus, a clear review and understanding of relevant intervention on the sector is of critical importance in developing the pro-poor economic policy in Bangladesh.

Progress: The main goal of the research is to evaluate how the policy intervention is dominated by top-down approaches reflected in highly centralized planning and blanket intervention processes. To conduct the study, data are being collected using both quantitative and qualitative methods through structured interviews, focus group discussions (FGD) and merging of knowledge (MoK) of key informants. So far, a total of 591 sample surveys, 5 MoKs and 2 FGDs by BAU and SAU components have been conducted. Investigations on community responses to top-down policy interventions will be identified while majority community areas attempt to implement policy strategies. The policy focus includes facilitating small farmers’ transition into modern food systems, agricultural modernization, diminishing soil and environment degradation, conservation of water bodies, protecting the hydro-geological basin and biodiversity, food system development, etc. The study findings and outputs will also focus on attitudinal problems based on the top-down policy practices. The research will suggest the need to introduce new way of policy intervention that would take into consideration the contemporary context for agriculture and development approach.



*Homestead duck hatching enterprise
Ujandall, Chaprir Haor Derai Sunamganj*

51. Project Title: Formulation of biopesticides to control bakanae disease of rice in field condition (ID 159)

Coordinator : Dr. Md. Mostafa Kamal, Chief Scientific Officer (Plant Pathology),
BRRRI, Gazipur-1701

Implementing organization : Bangladesh Rice Research Institute & Islamic University, Kushtia

General objective : Development of environmental safe biopesticide to control bakanae disease and to increase yield of rice

Duration : From October, 2019 to 30 June 2021

Budget : 8021000/=

Background: Bakanae caused by *Fusarium fujikuroi* is an endemic fungal disease in rice and has sporadic distribution in Bangladesh mainly in greater Cumilla, Habigonj and Mymensingh districts. But, the incidence of bakanae is increasing in Bangladesh (Haq et al. 2011) and growing more concern to rice growers as yield loss 21% -51.53% has been reported in Bangladesh (Hossain et al., 2013; Angeles et al., 2006). In the present perspective, it is essential to minimize yield loss due to diseases for increasing rice production in decreasing land area. Despite the considerable economic impact of bakanae, a few efficient and effective control methods are available, except the seed treatment with chemical fungicides. Because of the above limitations, more effective and environmentally sound control measures using antagonistic microorganisms and natural plant products commonly known as biopesticide might have an alternative approach to control *F. fujikuroi*. *Bacillus* spp. *Pseudomonas* spp. and *Trichoderma* spp. have been found to control many plant pathogens including sheath blight (Bhattacharjee and Dey, 2014; Kumar et al., 2012). Currently, *Bacillus* spp. is identified as a successful biopesticide for controlling bakanae disease (Hossain et al., 2016). *Trichoderma* spp. also identified as a very proactive bio controlling agent for sheath blight disease management in Bangladesh (Jahan et al., 2016; Kamal and Shahjahan 1995). Recently, in different parts of the world, attention has been paid towards exploitation of higher plant products as novel chemotherapeutants in plant protection. Therefore, it is worth to look for environmentally and toxilogically safe and more effective methods (biopesticide) to control Bakanae disease and to replace chemicals gradually with biopesticide(s) which are safe to human, and non-target to other beneficial organisms and cheaper than the chemicals.

In the mean time, 40 biocontrolling bacteria, 6 *Trichoderma* spp., have been identified that can inhibit mycelia growth of bakanae causing pathogen in vitro 61-94% from CRG sub-project (ID 712) under PIU-BARC, NATP-2. Among the identified biocontrol agents two biocontrolling bacterial isolate (NS 9-4 and Bio-1) and one *Trichoderma* isolate (T3) were tested on seedlings as root dip method and found promising to manage bakanae disease in comparison with control (inoculated). Moreover, four plant products/ active ingredients (neem seed extraction in ethanol, neem leaf extraction in ethanol, mehogoni extraction in ethanol and dodder plant extraction in ethanol) have been identified to inhibit (100%) mycelial growth completely of the bakanae causing pathogen in vitro. As the biocontrol agents/active plant products were identified as effective in vitro condition only and could not evaluate in field condition it is aimed to use plant products to formulate biopesticide singly or in accordance with the identified effective biocontrolling agent(s) against bakanae disease management.

Progress: One formulation for *Trichoderma* biopesticides is done using suitable carrier material. Nano particle from neem leaf, dodder plant and mehogoni plant was produced and need to optimize for absorption intensities of the produced nano particles. DNA of six biocontrol agents has been isolated and species identification process in progress. Green house study with the use of biocontrol agents is going on and field's trial will be evaluated as soon as possible. Moreover, nano particle of the identified plant products will be used to manage the disease at farmer's field level condition.

Chapter 4

Coping mechanisms undertaken during COVID-19 period

GoB has closed all offices from 26 March 2020 considering the worldwide pandemic situation of COVID – 19, and is being continued till 30 May 2020. Accordingly most of the field works, field survey, field experiments, laboratory analysis and data collection stopped due to close of all universities and research institutes. When locked down situation is continued over two month, PIU-BARC made a short assessment on PBRG sub-projects implementing in the field as well as implementation status of PhD programs, training, workshop/seminar etc. over mobile phone. The output of quick assessment indicated that executing foreign training will suffer much while implementation of PBRG sub-projects may need time extension for numbers of sub-projects especially the ones with survey-dependent, farming systems, agro-forestry, soil improvement and fisheries components.

4.1 Monitoring during COVID – 19 locked down

When the lockdown situation continues for couple of weeks, the monitoring and research sections jointly did a quick assessment on the impact of general holidays upon the field activities through telephonic conversation and submitted a primary report to the PMU in 2nd week of April 2020. Afterwards a simple monitoring format designed and send to all PIs for collecting information on the possible damage of project field and lab activities. Compiling information from around 60 PIs a second monitoring report submitted to the PMU in 1st week of May 2020. Another updated monitoring report (information form 44 PBRG sub-project and 120 PIs) submitted to the PMU in 1st week of June 2020. These monitoring reports highlighted the feedback received from PIs of PBRG sub-projects and local & foreign PhD scholars, which has been discussed in the relevant sections.

4.2 Impact of COVID – 19 locked down on field implementation of PBRG sub-projects

The M & E Specialist of PIU, BARC made consultation with the PBRG sub-project's coordinators, consultants, monitoring associates of PIU, BARC and Principal Investigators (PIs) of numbers of sub-projects for last couple of months. Based on the telephonic investigation and discussion with the stakeholders the following statements are prepared. In addition of consultation, a format sent to all PIs for feeding the information regarding corona effect on the field/lab activities of their PBRG sub-projects and by this time PIU-BARC received responses from around 120 PIs of 43 sub-projects. Compiling the responses received from both sources, a matrix has been developed and shown in the Table 4.1.

Assessment on the impact of COVID-19 pandemic on the activities of PBRG sub-projects

Considering the worldwide pandemic situation of COVID – 19, Government of Bangladesh has closed all offices from 26 March 2020 and is being continued till 16 May 2020. Accordingly most of the field works, field survey, field experiments, lab analysis and data collection are stopped due to close of all the universities and research institutes. Due to COVID-19, when locked down situation is continued over a month, PIU – BARC made a short assessment on PBRG sub-projects implementing in the field through supplying format by email to all Coordinators and Principal Investigators (PIs) and by investigating over mobile phone.

About 120 Coordinators and PIs of 40 PBRG sub-projects responded in the on-line survey. Quick assessment of the received responses from the Coordinators and PIs of the PBRG sub-projects indicated the following major findings : i) Majority PIs anticipated no or limited impact of corona pandemic on the field activities of the PBRG sub-projects on faming system (ID # 061, 096,098) agricultural engineering/ machinery (ID # 001,

002, 064), technology transfer (ID # 005) etc. These sub-projects are field oriented and mostly managed by cooperative farmers under the guidance of field staff of research institutes; ii) A good number of PIs assumed time extension for their sub-projects, those have lab analysis (ID # 029, 030, 134, 135, 156, 159), data collection (soil management: ID # 043, 134, 135); field surveys (AERS sub-projects: 021,070,156); fisheries & mud crab (ID # 029, 036, 037); and nutritional analysis sub-projects (ID# 007,011,099,103); iii) Many of the PIs reported that farmers faced acute problems of low prices of vegetables, fishes and milk in the market due to lack of demand related with the communication breakdown throughout the country; iv) Numbers of poultry rearing cycles might be dropped due to lack of supply of all sorts of inputs; v) The fruit orchards and nurseries including tea gardens are facing management problems due to absence of required numbers of staffs of the sub-projects; vi) Large numbers of PIs are hopeful to complete their sub-projects by time schedule but simultaneously they mentioned if the locked down continued for months then time extension could be needed to achieve the set objectives and for completion of the sub- projects. The output of quick assessment indicated that implementation of PBRG sub-project may need time extension for numbers of sub-projects especially the ones with survey-dependent, farming systems, agro-forestry, soils improvement and fisheries components. However, compiling the responses received from both sources, Impact of Corona Pandemic on field implementation of PBRG sub-projects is shown below in Table 4.1:

Table 4. 1: The impact of COVID-19 pandemic on the activities of PBRG sub-projects

SI #	ID#	Sub-project title	Remarks/Observation
1	001	Up-scaling and Application of Solar Photovoltaic Pump for Smallholder Irrigation and Household Appliances in the Central Coastal Region of Bangladesh	BARI & BRRI components: Sub-project coverage: Barishal, Patuakhali, Barguna, Pirojpur and Bhola districts. The solar pump mainly tested in rabi season with boro rice, brinjal, tomato and watermelon. Except arrangement of field days in experimental sites no major damage anticipated.
2	002	Groundwater resources management for sustainable crop production in northwest hydrological region of Bangladesh	BARI & BINA components: The crop coverage are boro rice, wheat and lentil; as would be harvested by farmers possibly no loss will incur. But Ground Water (GW) assessment in April may hamper due to absence of field staff. Still no major damage is anticipated. GW assessment is mainly made in rabi/dry season.
3	005	Transfer of Agricultural Technologies to farmers' level for increasing farm productivity	BJRI component: Technology transfer trials for Jute by BJRI may suffer due to delay or no planting of crops in Kharif II season. BSRI component: Twenty (20) demonstrations of Chewing (10) and Gur variety (10) were planted by BSRI properly along with potato as 1 st intercrop and mungbean as 2 nd intercrop. Nearly 60% data collection completed. Cultural practices of sugarcane may be slightly hampered. SRDI component: SRDI planted boro rice (BRRI dhan 58) in Cumilla and Tangail and crops are in booting stage. BINA component: BINA grown boro rice, which is under booting stage and aus in seedling stage; no damage expected.

4	007	Value addition and standardization of nutritional level in selected food items from Animal and plant origin	PSTU & HSTU components: One or two poultry rearing cycles may need to be repeated as feeds could not be transport to the farm site. Data analysis will need external lab support, communication breakdown would affect analytical part and verification and refinement of data. Time extension for few months (4-6) is anticipated
5	010	DNA marker assisted breeding for production highly stress tolerant rice for coastal Bangladesh by introgression of multiple salt tolerant loci (QTLs) into commercial cultivars	BIRRI & DU components: Genotyping selection by KASP marker completed at Dhaka University (DU) before lockdown. Based on genotype, plant selection completed and 2 nd backcrossing almost completed during lockdown at BIRRI, Gazipur. Therefore there is no visible impact on research work due to lockdown
6	011	Food-based initiative for improving household food security, income generation and minimize malnutrition	NSTU component: Scheduled nutritional health survey of fish farmers in March/April may affect if locked down continued for months together. Supervision by local staff stopped due to lock down. Activities are on-going using farmer's management through telephonic conversation. No major problems anticipated due to present locked down situation
7	016	Integration of Postharvest Technologies and Best Practices in the Value Chains of Fruits and Vegetables	BARI component: Carrot storage samples scheduled to be collected from Savar and mango bagging in 1 st week April at Rajshahi, which could not be possible. Time extension is suggested. DU component: Field experiments on brinjal (eggplant) in Bogura site supposed to be done on 3 rd week of April 2020. The egg plants are at harvesting stage now at Bagura, which is restricted by lockdown that will result no microbiological, chemical and physical analysis. This work will be done in next available season in the 3 rd year of the sub- project
8	020	Development of Production Package of Export and Processing Potatoes to Sustain Productivity and Food Security in Bangladesh	BARI component: No major problems are anticipated, hurriedly completed harvesting. Facing little difficulty to send the materials to Quasem Food Product Ltd. for commercial estimation of processing. Postharvest storage data are being collected, if lock-down situation continued, it may partially affect post-harvest data collection. SAU, Dhaka component: Completed all scheduled field experiments and data collection. Data analysis partially may be affected as students are

			Giant agro component: Potato already harvested, set experiments to collect data from different storage systems (conventional method, seed potatoes storage and CIPC storage). Data collection may face slight problems.
9	021	Cost and Return Analysis of Selected Crops in Bangladesh	BARI component: Necessary data collection completed (97%). FGD for sesame and pea nut is being affected by locked down situation, to be continued later. Sub-project could be completed without major damage
10	029	Adoption of Innovative technology: Seed to fattening of mud crab (<i>Scylla olivacea</i>) and health management in Bangladesh condition	BFRI component: COVID-19 enhanced slowed export market (China) resulted limited samples from mud crab farms from January 2020, very limited samples from mud crab. However, most samples collected up to now are being analyzed, and the remaining to be collected after lock-down situation.
11	030	Investigation and characterization of viral and bacterial diseases in selected fin fish and Shrimp in Bangladesh, vaccines development and validation	BFRI & BAU components: Completed isolation and characterization of important bacteria responsible for fish mortality (<i>Aeromonas spp.</i> & <i>Vibrio spp.</i>) and started trial production of feed based monovalent, bivalent and trivalent fish vaccines with newly isolated two bacterial species and previously characterized bacteria from the popped eye disease of Tilapia and V. koi. It is planned to start lab and field trials from mid April 2020 but COVID-19 pandemic may stop the research on the production of trial vaccines. If it continued till the end May, 2020 it will difficult to start the trial experiment of newly developed fish vaccines in the lab and in field as well. So this corona pandemic may force to extend the time schedule of complete the research
12	031	Development of in-situ Breeding Technology of Prawn (<i>Macrobrachium rosenbergii</i>) and Adoption of Sustainable Eco-Friendly Culture of Prawn and Shrimp (<i>Penaeus monodon</i>)	KU component: Field trial is on-going and around 70% work completed. Till 3 rd week of March, 2020 all activities have been recorded as per requirement of NATP-PBRG sub-project. Afterwards, due to COVID-19 the University has been closed and students left, but collection of field samples are being continued by a field labor. Final harvesting to be done in May. Data gathering and analysis to be done by students after their return. Corona pandemic would delay the works. BFRI component: It has both field and laboratory-based research objectives. The lab base activities are mainly dependent on the collected samples from the farmers' pond and different river. Corona Pandemic stopped field sampling. Hatchery and Pond for shrimp post larvae (PL) stocking have

			<p>been completed but due to lockdown situation, getting shrimp PL become little bit challenging. Sub-project personnel are waiting for the convenient situation. If situation prevails for months more it will affect the season and will have need another fish culture season</p>
13	035	<p>Techniques Adoption and Formulation of guidelines for Sustainable management of Haor and Beel Fisheries</p>	<p>SAU, Sylhet component: Repair and maintenance of sanctuaries & pens done by 31 March. Local community people are engaged to protect the sanctuaries in addition of two locally hired labors. PI and students are communicating with them via cell phone. Fish catch assessment and survey was continued directly until March 2020. Water quality monitoring, sediment and plankton collection were continued till 24 March 2020. Samples have preserved and analysis will continue after opening of university. Collected small indigenous fish species (mola) rearing is continuing in a local fish farm. Transfer of SIS into the pens in Apr could not be made due to locked down. Fishers are passing difficult time due to low price of fish in the market. Time extension for one season is anticipated</p> <p>SUST component: Water samples from the Shari-Goyain River collected with some difficulties (for the last month) but could not be tested due to shut down of laboratories of SUST. Water samples collection from the river in future would be difficult if corona pandemic continue. Activities like current measurement, cross section measurement, water level measurement etc. to assess the level of siltation of Shari- Goyain river at this moment has stopped due to unavailability of field staff. Sub-project completion would need time extension</p> <p>RU component: Sub-project coverage: Shingra (Natore) and Chatmohor (Pabna). Monthly</p>
14	036	<p>Post-harvest Losses, Supply and Value Chain Analysis of Fisheries Sub-sector in Bangladesh</p>	<p>BAU & PSTU components: All enumerators are given up from the field since 15 March 2020. PI, CO-PI, PhD student, computer operator are locked down at home since 26 March 2020. Data entry is being hampered .Money disbursement is delayed due to COVID-19. However, data entry and analysis is continued in limited scale. Locked down happened during fish producing season, all fisheries sub-projects will suffer in different scales. Low price of fish due to abnormal market will produce erroneous data</p>

15	037	Improvement of existing fattening technology of carp and high valued small indigenous species (SIS) through good aquaculture practices (GAP) in different agro-ecosystems	<p>PSTU component: Till last week of March 2020 the sub-project harvested fishes from 13 ponds out of 18 and lock down situation forced to stop further harvest, to be done after withdrawn of locked down.</p> <p>RU component: It is anticipated that except trial like 'Development of live fish transportation technique' other activities will not be hampered. For fish transport experiment, smooth data collection (for at least four months) is subjected to the smooth transportation during locked down situation, however, no major constraint faced to date. The sub-project is suffering for low price of fattening fishes. No major problems is expected to complete the sub-project.</p>
16	043	Microbial Characterization of Bangladesh Soil and Development of Climate Smart Bio fertilizers for Crop Production and Soil Fertility	<p>BARI component: For microbial characteristics 50 soil samples collected out of 240. Rest will be collected after lock-down situation. Microbial characterization has completed for 15 samples and rest to be done after lock-down situation. Pot trials/experiments are going on at greenhouse of Soil Science Division, BARI. No major damage anticipated.</p> <p>BRRI component: For microbial characteristics 140 soil samples collected out of 240. Rest sample will be collected after lock-down situation. Bio-chemical analyses completed for 30 samples and rest to be done after lock-down situation.</p> <p>BINA component: Soil samples from different AEZs of country and analytical work in the laboratory is yet to be started. If lockdown continued it will hamper the project works (laboratory analysis, pot and field experiment).</p>
17	051	Validation of Crop Intensification Technologies for Improving System Productivity, Soil Health and Farm Income in South Central Coastal Region	<p>ARF component: Conducted experiment on grass pea in rabi season and harvested good crop one site (Rajapur of Pirojpur) while experiment in other site (Kawkhali, Pirojpur) could not be planted due to late rainfall. Set trials on mungbean using BARI Mung- 6 and BU Mung -5 at four Upazilas (Nalchity and Rajapur of Jhalakati district and Bhandaria and Kowkhali of Pirojpur district). Except in one farmer's plot in Rajapur Upazila, there has been excellent crop growth. The crop is in pod-filling and maturity stage. The pandemic corona outbreak restricted movement of scientists beginning early March 2020; but the scientists regularly made contact with and advised sub- project and ARF staff and the cooperating farmers as well in taking care of the experiments. Crop growth of BU Mung -5 is</p>

			<p>experiments. Crop growth of BU Mung -5 is reported better than BARI Mung- 6. No major damage of activities is anticipated.</p> <p>BARI component: Before corona pandemic situation, data collections were completed for mustard, sweet gourd, khesari grown in sadar and kalkini upazilla of Madaripur, sadar and Mollarhat upzilla of Bagerhat. During this locked down situation Mungbean, Sesame/Till, Jute sown in 6 locations. So major problems will not occur as these experiments are managed by farmers</p>
18	054	Introduction of Profitable and Agro-Ecologically Suitable Crop Varieties and Development of Marketing Systems for the Charlands of Northern Bangladesh	<p>BAU component: Groundnut and chilli have been harvested successfully from the pot culture. Planting of maize and foxtail millet in the pot culture may be dropped if this febrile calamity prolongs. No major problems anticipated for project implementation due to present situation. The low price of vegetables enhanced farmer's sufferings</p>
19	061	Integrated Farming Research and Development for Livelihood Improvement in the Plain land Eco-system	<p>BFRI component: Farmers are producing Ladies finger, Tomato, Radish, Cucumber, Yard Long Bean, Cucurbit, Sweet Gourd, Brinjal, Amaranth, Bitter Gourd, Red Amaranth, Red Spinach etc. But locked down cut off the market channel and they have suffered to sale out the products. Fish stocking not yet possible in ponds due to unavailability of fingerlings (cutoff transportation), may be delayed or drop the experiment if lock down continued. Low price of vegetable due to communication breakdown. The PIs of all farming system sub-project complain about low price of milk and fishes</p>
20	064	Design and development of fertilizer deep placement mechanism for existing rice transplanter	<p>BRRRI components: A total of 07 trails set in rabi season in different locations. Data collection continued using the local skilled persons/SAAO of DAE and through mobile phone. Workshop activities partially continued to modify the technology based on field problems. Crop cut will start from 10th May, 2020. Data analysis, report writing and presentation preparation is continued under locked down condition. Field experiments (2) are going on at farmers' field, Kushtia and BRRRI farm, Gazipur. Plants are at PI stage. All treatments and fertilizer were applied in proper time. Greenhouse gas collection is on going under lock down situation.</p> <p>Greenhouse gas (CH₄, CO₂ and N₂O) analyses at laboratory will be start after lock-down situation. So no major problems for completion of activities are expected.</p>

21	070	Economic Viability and Production Efficiency of Rice: A Macro Level Study in Bangladesh	BAU component: The sub-project's objective demands data collection from field through survey and FGD. The locked down situation would somehow delay the process of data generation for few months. In fact, 5-member enumerator team returned from Lama Upazilla of Banderban district on 19 th March 2020. However, the team will have to collect the planned data from the field through field survey and FGD when the situation will come to normal.
22	072	Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based agroforestry system to mitigate the climate change	SAU, Sylhet component: Plantation of missing cuttings/saplings of moringa, chuijhal and black pepper in tea gardens will be delayed by couple of months. Overall the completion of the scheduled activities of the sub-project will be delayed, would need time extension
23	074	Exploration, Identification, Characterization, Multiplication and <i>Ex-situ</i> Conservation of Endangered Forest Genetic Resources including Medicinal plants of Bangladesh	BAU component: Germplasm of medicinal plants have been collected, planted and conserved at BAU-GPC. Characterizations are going on. Multiplications of medicinal plants are continuing in the field. Periodical data are recording time to time. No damage expected CU component: Experiments established for studying seed biology of 11 threatened tree species in the nursery and propagator house are maintaining regularly (watering, weeding, providing shade etc.) by the staff. Seedlings of some tree species in the nursery are maintaining regularly. Established Conservation Plots of 30 threatened tree species. No damage will occur due to corona locked down. BFRI (Forest) component: Due to communication breakdown, collection of forest plants from three hill districts will suffer
24	077	Upliftment of Farmers Livelihood and Enrichment of Environment through Improved Agro-forestry Practices in Char Land Ecosystem of Bangladesh	BAU & BARI components: Analysis and reporting of rabi 2019 have already been completed. Different summer vegetables/crops are in the field. Management of existing field vegetables may partially affected by the corona pandemic situation. Another crop season may be needed to complete the planned the crop cycles
25	096	Improvement of Farm Productivity through Intervention with Improved Agricultural Technologies in Char land Eco-System	BARI component: Wheat, onion and garlic already harvested. Mungbean is to be sown soon. Activities are continuing through farmers by telephonic message. No major damage is anticipated. BINA component: Vegetables cultivation and harvesting as per plan is on-going. Maize has already been harvested and sowing of Jute seed completed. Beef fattening and pigeon activities will have no problems.

26	097	Livelihood Improvement of Farmers through Integrated Farming System Research and Development of Drought and Rain-fed Ecosystem	BARI component: The PI has completed the planting of Kharif I crops (maize, sesame etc.), so no damage is anticipated though movement of local staff restricted. As these experiments are in farmers field no major problems would occur
27	099	Fortification and standardization of nutritional level in selected human foods and efficacy test of polyphenolic compounds in livestock	BARI component: On-going research activities on impact studies on rice based food items in street children will be badly hampered due to Corona Pandemic. BARI component: Trial experiment set up for optimization of processing parameters for developing quality banana and potato (BARI variety) chips completed and nutritional quality and shelf life study is in progress. Two experiments design on Standardization of temperature-time combination with packaging for preparing quality sweet potato and carrot chips completed. Experiment will be conducted after Corona disaster
28	108	Development of knowledge hub on Animal Feed Resources for efficient feeding management of ruminants to enhance productivity	SAU, Sylhet component: Corona locked down situation would have serious effect on feed sample collection especially during this dry period from Patuakhali, Sathkira and Sumamgonj. Besides, the research students are also absent in university campus, and lab work is stopped. On the other hand dairy trial was set up but collection and analysis of feed and milk sample is not possible. The sub-project would need time extension for completion of designed works and conclusions
29	128	Collection and Characterization of Important Plant Genetic Resources	BARI component: Rice germplasm could not be completed, Aus 2020 sowing/ transplantation for characterization may not be possible. BAU component: All conserved PGR of banana and aroids are maintaining and saplings are supplying as demanded. Regarding yams, last two years data are compiling by the researchers, this year plantation has been done. As all plantations are now in BAU-GPC so no problem on taking care, data collections and managements. No effect of corona is expected BARI component: Characterization of crops like summer vegetables (okra, cucumber, gourds, mungbean, yard long bean etc.) may be affected due to failure of panting season. Collection of germplasm of concerned crops by all organization would suffer due to breakdown of communication. This locked down situation may induce/prompt time extension for the sub-project to achieve its objectives

			<p>BINA component: Three characterization experiments (Sesame, Peanut and Okra) are in the field. Data recording is being done as and when necessary. But if the situation prevails for another 2-3 months, it may affect to fulfill the target of germplasm collection, and also molecular characterization.</p>
30	134	Determination of Critical Limit of Nutrients for Soils and Crops	<p>BAU component: Practically corona pandemic would have no direct impact on the activities of ID 134 PBRG sub-project. Before corona pandemic situation, pot experiment and data collection has been completed. At present, lab work especially chemical analysis is going on by maintaining corona precautions.</p> <p>BRI component: Fortunately till now Corona Pandemic has not impacted on the activities of ID 134 sub-project. Pot trials on determination of critical limits of P, K, S and Zn in soils and rice plant have been harvested on 8 to 12 April 2020. Sample processing like drying and weighing is going on smoothly. Pot trials on critical limit determination of P, K S and Zn on rice are going on. Critical limits according to "Cate and Nelson" will be calculated to include in the annual report. Chemical analysis of plant samples will be done accordingly. Only the soil analysis may be delayed but no major problems is anticipated</p> <p>BINA component: Corona pandemic has no direct impact on the activities of the sub-project. Before locked down, pot experiment and data collection has been completed. Pot experiment of Kharif-1 maize harvested on 20 April 2020. No problems expected.</p>
31	135	Improvement of soil health and crop productivity in climate vulnerable and polluted areas through organic amendments	<p>BRI component: Field experiments (3) are going on at farmers' field of Sripur, Mirzapur and Pirujali. Plants are at PI stage. Chemical analyses at laboratory will be start after lock-down situation.</p> <p>BAU component: Activities are going on as usual, except small problem with field work at Madhupur and Islampur sites. Boro rice is in the field of Madhupur and Maize harvested at Islampur (Jamalpur) site. Jute sown in Islampur. Expecting the field activities would continue without damaging any crop.</p> <p>BINA component: So far the pandemic Covid-19 has not impacted. Currently analysis of data and reporting for 2nd year (March 11, 2019 to March 10, 2020) is on-going. If the situation continues for another 1-2 months, the sub-project will be</p>

			<p>affected. At present field experiment (boro season) is going on at Nachole Upazilla, Chapainawabganj. Sample analysis in Lab could not start as the situation is getting worse.</p> <p>BARI component: Field trial on organic amendment of acidic soil using okra is continuing at Belabo upazila, Narshindi; drought prone soil using boro rice is continuing at Ghodagari upazila, Rajshahi and saline soil with Sweet gourd has been completed at Dumuria upazila, Khulna. Impact of Corona pandemic is expected to be minor, may be delayed the starting of mineralization study.</p> <p>BSMRAU component: The sub-project coverage (sites) are: saline zone at Dumuria (only T. Aman); arsenic contaminated area at Faridpur Sadar (T. Aman – Boro); and industrial polluted area at Valuka (T. Aman – Aus). Boro will not be affected but Aus will have to be dropped if lock down continued for months.</p>
32	138	Determination of Antimicrobial Resistance and Residues in Livestock and Poultry Food Products and Feed in Bangladesh	<p>BAU component: Samples collection (70%) for Microbiological Study completed. TLC and HPLC analysis are ongoing but temporarily suspended due to lockdown. Time extension may be needed if lockdown prolonged for months.</p> <p>BLRI component: Sample has already been collected from Gazipur and Tangail, ready to antimicrobial residues analysis. Rest of the sample will be collected and analyzed after the lock-down situation. Study of antimicrobial sensitivity/resistance pattern and detection of resistance bacterial genes will be started after the lock-down situation.</p> <p>RU component: Survey has been completed by using semi-structured questionnaires in different farms, vet practitioners and medicine sellers. Collection of livestock and poultry samples (meat, egg, milk, feces and feed) completed and sent to BAU for antimicrobial residues detection. Sample analysis are on-going. Detection of resistance genes by using PCR analysis in bacterial isolates will be done after the lock down situation.</p> <p>HSTU and SAU, Sylhet components: Provided similar information as of RU component.</p>

33	151	Transformation of Agriculture for Food Security and Poverty Reduction	BAU component: The COVID-19 pandemic and the consequent lockdown have halted almost all the activities of the sub-project. BAU is closed and there is no scope of work at all. Preparation of survey tools of different types were under way of completion but lockdown has stopped everything. Even, the validation workshop for reviewing survey tools has been postponed. The pre-visit of sites had been started but got halt. Time extension would possibly be needed
34	152	Development of protective culture technology for safe and quality vegetables and fruits production	SAU, Dhaka component: So far no impact of corona but if it prolonged for months affect the completion of existing field experiments. The completed experiments are: <ul style="list-style-type: none"> a. Effect of different shades on growth and yield performance of strawberry b. Effect of different mulching material on the plant growth, quality and yield of Strawberry c. Effect of different growing media on growth, yield and fruit quality of Strawberry under protective conditions <ul style="list-style-type: none"> • The on-going ones are: <ul style="list-style-type: none"> a. Nutrient management of banana and papaya b. Effect of different shades on growth and yield performance of banana, papaya and dragon fruits d. Effect of maturity stages on the quality of papaya and banana fruits e. Manipulation of sex expression by plant growth regulators and quality enhanced by potassium in muskmelon
35	153	Development of Production Package for Horticultural Crops in Rooftop and Open Space in Urban Areas of Bangladesh	SAU, Dhaka component: One rooftop was allotted by a committee authorized by University. Structures/Models are made partially but not completed and scientists were about to start vegetable cultivation package development for summer season but everything stopped due to this situation. Locked down would delay the start of the experiments. All planned cycles would not be completed if time is not extended. BARI component: 5 crops out of 8 have already been prepared for performance trial on the roof but others could not be set up due to lock down. This experiments needs to build specialized structure, which is under RFQ, which cannot be done. Out of three adaptive trials 2 have already 50% done (Land and pit preparation) but supply of saplings could not be done due to the current

36	154	Sustainable Development of Indigenous fisheries in <i>Baors</i> of southwestern Bangladesh through Multiple-Functions for Ensuring the Food Security	<p>RU component: Till March samples are collected and stocked brood fishes for spawning during this monsoon. Survey works with fishers, markets etc. started, but to corona pandemic it stopped, though others are continued. This current season may loss for the experiment, time extension is suggested.</p> <p>JUST component: The sub-project is implanting in the Baors (locked water body) at Jashore District since mid-October 2019. Started to collect samples from end Mar 2019 and stocked brood fishes for spawning during this monsoon. Surveys with fishers, markets etc. started but suddenly stopped due to corona locked down situations. Partial damage anticipated</p>
37	155	Exploration of Exogenous Enzymes, Bivalent Efficacy and Omega-3 Fatty Acid of Microbes and Small Invertebrates as Potential Feed Supplement for Enhancing Fish and Shrimp Productivity <i>Component:1 (BSMRAU)</i>	<p>BSMRAU component: The major activity of this sub-project is to collect sample from different corners of Bangladesh which is completely travel oriented task. So collection of sample is not possible as the country is now completely lockdown. Analysis of previously collected sample is not possible to continue as all the educational institute is completely shut down since 17th March 2020. Overall the sub- project activities are now completely lockdown. Damage of sub- project activities is anticipated</p> <p>NSTU component: COVID-19 has postponed field works (sampling) since 30th March 2019. However regular field monitoring and team discussion is continuing over phone to carry out our normal work. Regular works might not be possible if it goes like the current situation. COVID 19 will extend the duration by six months or so.</p> <p>BFRI component: Before corona pandemic situation, Pond preparation have been completed for shrimp post larvae (PL) stocking. It was for the In-vivo challenge test for antagonistic effect and efficacy of recombinant plasmid experiment. Due to the lockdown situation, getting shrimp PL has become little bit challenging</p>
38	156	Stock Assessment of Commercially Important Fishes in the Bay of Bengal through Multi-model inferences and molecular markers: Management policy implications considering the emerging climate change	<p>RU component: Filed works/research are conducting in the Bay of Bengal under this sub-project through four field-office-cum lab at Pathorghata (Borguna), Alipur (Kuakhata, Pauakhali), Chattogram (Fishery Ghat) and Cox's Bazar (BFDC fish landing center). Until March2020, samples have been collected from the Bay of Bengal and also BFDC fish landing centers. Started survey works with fishers, fish traders, officers, field workers etc. But suddenly supervision of fishers has been stopped due to corona locked down situations and regular fishing activities by</p>

			<p>the fishers are not going smoothly due to locked down. Sampling might be hampered, continuously monitoring is continued with field assistants who are still in the fields.</p> <p>SAU, Dhaka component: Corona pandemic has impacted on both field and lab experiment of the sub- project. Fish samples cannot be collected from coastal regions</p>
39	158	Analysis of Agricultural Policy on Food System and Rural Development in Bangladesh: Case of Haor Area (Wetland) Management Practice	<p>BAU component: COVID-19 pandemic has not yet negatively impacted the activities of BAU component. The field survey activities were performed without interruption up to 31 March 2020 by scheduled accordingly. Half- yearly target of survey was fulfilled. Around 30% of total farm survey has been completed. Data entry and analysis will be done after general leaves due to COVID-19 outbreak in Bangladesh. No major impact of corona is expected</p> <p>SAU, Sylhet component: The field survey activities had been performed up to 17 March 2020 (till the closer of the university) according to the approved schedule without any interruption. Similar responses provided by the PI as of BAU</p>
40	159	Formulation of bio-pesticides to control bakanae disease of rice in field condition	<p>BRR component: No chemicals, apparatus and equipment yet received from suppliers and couldn't start lab work. Field work was supposed to start in Aus season in Habigonj but it's not possible to start work in Aus season due to lockdown situation. Partner organization Islamic University synthesized nanoparticle from plants but couldn't test against the pathogen due to University closed in current Covid-19 situation. The sub-project duration is expected to be extended for one cropping season due to locked down situation.</p> <p>IU component: The research work has been seriously affected due to the Corona pandemic. Although nanoparticles from three different plants (Neem, Mehogany and Swarnalata) have been synthesized just before the lockdown, but could not be evaluated the in-vitro efficacy against the fungus <i>Fusarium fujikuroi</i>. The efficacy of silver nanoparticles can be evaluated after the lock down situation. Major difficulty to finish the sub-project works in time is anticipated.</p>

The statements of Principal Investigators in the remarks column would help to develop an idea on the impact of the lock down situation of the country against the on-going PBRG sub-projects in the field. However, it may be concluded that if the present situation continues for next one or more months, numbers of sub-projects would need time extension (No cost) for achieving the set objectives in the proposal.

The general responses mentioned by the PIs are:

- i) Majority PIs anticipated no or limited impact of corona pandemic on the field activities of the sub-projects (farming system sub-projects (ID # 061, 077, 096), agricultural engineering/machinery (ID # 001, 002, 064), technology transfer (ID # 005) etc.). These sub-projects are field oriented and mostly managed by farmers under the guidance of field staff of research institutes
- ii) Number of PIs assumed time extension for their sub-projects, those have lab analysis (ID # 029, 030, 064, 134, 135, 156, 159), data collection (soil management: ID # 043, 134, 135); field surveys (AERS sub-projects); fisheries & mud crab (ID # 029, 036, 037); and nutritional analysis sub-projects
- iii) Many of the PIs reported that farmers faced acute problems of low prices of vegetables, fishes and milk in the market due to lack of demand related with the communication breakdown throughout the country
- iv) Numbers of poultry rearing cycles might be omitted due to lack of supply of all sorts of inputs
- v) The fruit orchards and nurseries including tea gardens are facing management problems due to absence of required numbers of staff of the projects
- vi) Large numbers of PIs are hopeful to finish their sub-projects by time schedule but simultaneously they mentioned if the locked down continued for months then time extension could be needed to achieve the set objectives and for completion of the sub- projects. It is concluded that if the present situation continues for months together, numbers of sub-projects would need time extension (with or without cost) for achieving the set development objectives.

4.3 Benefits of farmers by on-going sub-projects during COVID-19

The short virtual survey indicated that numbers of PIs mentioned loss of Kharif -1season might need time extension for their sub-projects while many other stated partial loss and some of them are managing their research activities through the cooperative farmers. There are numbers of PBRG sub-projects with the objectives of technology transfers, improvement of existing farming systems including fisheries and adoption of agro-forestry systems, which are practically managed by selected cooperative farmers in the field. Sub-projects like code # 005: 'Transfer of Agricultural Technologies to farmers' level for increasing farm productivity' has 10 components operating by BARI, BRRI and other NARS institutes, implementing in the selected farmer cooperator's field and mostly managed by farmers in association with the local SAAOs or Scientific Assistants of OFRD, BARI. These sub-projects are continued as usual and farmers are getting agricultural inputs and produces as earlier and 20-25 farm families would be benefitted by this sub-project during this COVID 19 locked down condition. Similarly from farming systems sub-projects (ID # 061, 096, 097, 098) not less than 48 farm households; agricultural machinery sub-projects (ID # 001, 002) 60 families; fisheries sub-projects (ID # 037, 154) 566 beneficiary households (due to community based fishery projects at Baor of north western region) and from nutrition sub-project (ID # 011) 60 ethnic/indigenous families at Chattogram/Chittagong Hill Tracts are expecting to be benefitted under the COVID situation. Number of farm households are estimated based on numbers of components, sites and cooperative farmers per site by each of the sub-projects.

4.4 Impact of COVID -19 on PhD programs

A short on-line study during COVID-19 investigated to know whether locked down will put any impact on the

course and research work of PhD programs or not. The information collected from the scholars in 1st week of April 2020 indicated that most of local national PhD scholar will face major difficulty by corona pandemic to complete field works as of earlier speculated time. It is because, most of the national PhD students have set their field research (experiments) in own research organization (where they are scientists) and continued the field management but lab facility is out of function due to locked down. As on 18 May 2020, scholars informed all academics and lab works fully stopped. Research field own institute done successfully, but location/survey based field research did perform. Out 79 (1 died) scholars 10 (13%) informed damage of field/lab works and repeated again due to lingering of Covid-19 and need additional research cost. The Zoom meeting with Director PIU-BARC on 29 June 2020, eleven (11) in-country PhD scholars have no effect on their research. Rest 68 is affected on research and /or course works by Covid-19. All universities are remaining closed since 25 March 2020. Covid-19 situation is worsening day by day which may increase the number of affected course and research work, so they would need time extension of 6 months with additional funding. The situation is bit different for foreign PhD scholars, significant numbers of scholars (>50%) informed earlier (April 2020) that corona would might need extension of their PhD duration by 6 or more months. Many scholars earlier said they would need extra time to finish the degree and this locked down again put extra burden of load to them. But during the meeting on 14 June with Director PIU-BARC out 60 scholars 30 were in informed damage of field/lab works & needs repeat and all of them desired time extension for at least 6 months with scholarship, tuition fee, research cost & other ancillary costs. Considering the present and earlier study it could be assumed that 6 months-time extension would possible be needed. Considering the fact PIU-BARC proposed additional funding under PhD programs in the revised DPP.

4.5 Virtual meeting during COVID – 19

During last week of Mar 2020 to 1st week Jun 2020 the Director, PIU BARC organized and attended numbers of virtual meeting with the PMU, Executive Chairman BARC, IMED and PIs of the PBRG sub-projects. The meetings are:

- The Director PIU-BARC attended meeting with PMU team and PIUs of NATP-2 on 8, 13 and 14 (night) April 2020 and 05 May 2020;
- On 16 Apr 2020 the Director, PIU-BARC conducted 1st meeting via video conference with 14 members of PIU-BARC (consultants, and other officials) at 11 am to 12:30 pm;
- On 08 May 2020 the Director, PIU-BARC conducted 2nd meeting via video conference with 14 members of PIU-BARC (consultants, and other officials) at 11 am to 12:30 pm;
- On 19 May 2020 the Director PIU-BARC arranged another Zoom Cloud Meeting with coordinators/PIs of PBRG sub-projects, which was conducted by the Executive Chairman, BARC with 44 participants (coordinators, PIs, consultants and other officials of PIU-BARC);
- On 8 June Director PIU attended virtual meeting with IMED in connection with monitoring report of NATP-2 prepared by Jans Consultant after getting contract from IMED;
- On 14 June 2020 the Director PIU-BARC arranged Zoom Cloud Meeting with foreign PhD students to know the present status; and
- On 29 June 2020 the Director PIU-BARC arranged another Zoom Cloud Meeting with local PhD students to know the present status.

All proceedings and decisions were properly documented and worked as per decisions of the meetings. According short email survey was done for impact of COVID -19 on the activities of PBRG sub-projects.

Chapter 5

Human resource development

PIU-BARC has provision of higher studies (local and foreign) and skill development training for scientists of NARIs. Efforts were made to develop the quality of scientific manpower who are directly involved in technology generation to ensure food security of the nation by inducing stress tolerance gene in locally adopted crop genotypes and by mitigating the challenges of low yield potentials of local crop varieties/genotypes.

5.1 Status of higher studies (Local and foreign PhD)

The DPP of NATP-2 has provision of 140 PhD programs of which 80 are allocated for local and 60 for foreign universities. Among the 80 local PhD programs, 60 allocated for NARS scientists and 20 for mid-level civil servants of DAE (10), DLS (05) and DoF (05). PIU-BARC, NATP-2 has already been awarded 140 PhDs (60 foreign and 80 local) to the scientists of NARS Institutes 118, DAE 10, DLS 05, DoF 05 and Ministry of Agriculture 02. All scholars both home and abroad completed their admission in different public universities. Out of 60 foreign PhD programs, 10 scholars have admitted in developed countries (USA, Germany, UK, Australia, and Japan) while 50 admitted in developing countries (Malaysia, Philippines, Thailand, China and India). One scholar of Bangladesh Fisheries Research Institute died on 16 January 2020.

Due to the selection process and time adjustment of admission by semester, numbers of PhD scholars (both foreign and local) would exceed their completion time of PhD program than the project duration (Sep 2021).

5.2 Contribution of PhD programs to achieve NATP objectives

The set development objective of NATP-2 is to increase agricultural productivity of smallholder farm and improve smallholder farmers' access to market in the country. The PhD programs of NATP -2 offered basically based on the need assessed by NARS institutes i.e. need of country's current agricultural demands in respect of improving agricultural productivity and marketing of perishable crop products for the marginal and small farmers. Considering this national focus, majority of PhD scholarship offered on varietal improvement (20%), stress physiology (13%) in context of different stresses like salinity, drought, water logging tolerant, shorter duration rice to address crop damages, crop protection and natural resource management are more than 10%, post harvest loss, vaccine development, etc (Fig. 5.1). The PhD researches supported to the scholars of NARS institute, and extension agencies are directly related to increase the productivity and production of crops, livestock and fisheries that seems to be very close to the PDO of NATP -2.

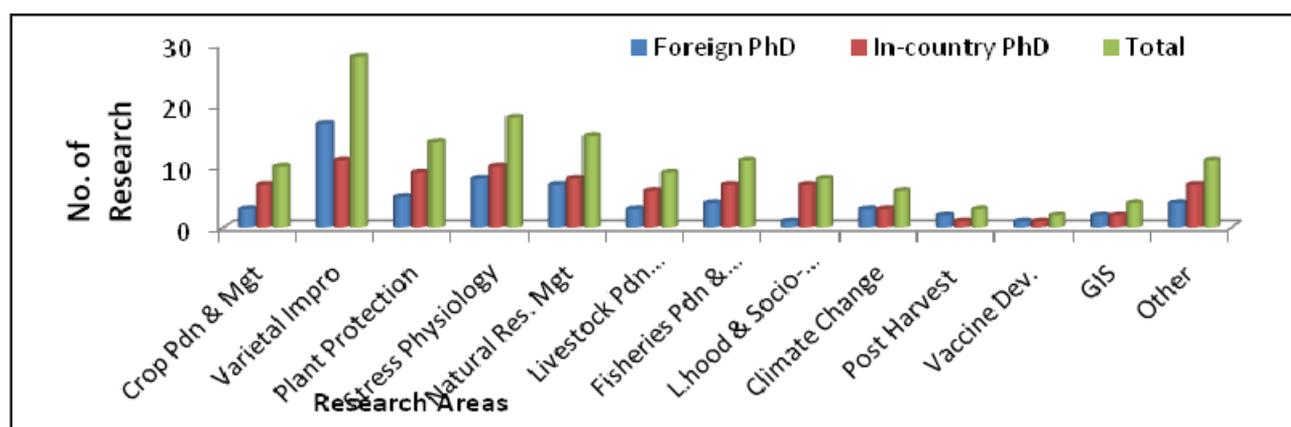


Figure 5.1. Alignment of PhD research areas with different disciplines.

5.3 Institute wise distribution of local and foreign PhD programs

The table 5.1 showed the distribution of foreign and local PhD programs among the NARS and other institutions/organizations. BARI as large national research institute shared highest numbers of local (21 of 80 i.e. 26%) and foreign PhDs (19 of 60 i.e. 32%). The next highest share of local (06) and foreign (10) PhD programs has received by BRRI scientists. The details of distribution of local and foreign PhDs are shown in the following table 5.1.

Table 5.1: Institute wise list of awarded local and foreign PhD programs

SN	Name of institute	No. of awarded PhD		
		Local	Foreign	Total
1.	Bangladesh Agricultural Research Institute (BARI)	21	19	40
2.	Bangladesh Rice Research Institute (BRRI)	06	10	16
3.	Bangladesh Institute of Nuclear Agriculture (BINA)	04	05	09
4.	Bangladesh Jute Research Institute (BJRI)	05	04	09
5.	Bangladesh Sugar Crop Research Institute (BSRI)	05	04	09
6.	Bangladesh Tea Research Institute (BTRI)	01	01	02
7.	Soil Resources Development Institute (SRDI)	04	03	07
8.	Bangladesh Sericulture Research & Training Institute (BSRTI)	03	-	03
9.	Bangladesh Fisheries Research Institute (BFRI)	06	05	11
10.	Bangladesh Livestock Research Institute (BLRI)	02	04	06
11.	Bangladesh Forest Research Institute (BFRI)	02	02	04
12.	Cotton Development Board (CDB)	01	01	02
13.	Ministry of Agriculture (MoA)	-	02	02
14.	Department of Agricultural Extension (DAE)	10	-	10
15.	Department of Livestock (DLS)	05	-	05
16.	Department of Fisheries (DoF)	05	-	05
Total		80	60	140

5.4 University with no/minimal course work in foreign PhD program

Fifty six (56) scholars have been doing course work based PhD out of 60 and rest are research based PhD program (Table 5.2). Forty three scholars have been doing course work based research and rest are under research based PhD program (Table 5.3). In case of In-country PhD, highest number of scholars admitted at Bangladesh Agricultural University (49) then Rajshahi University (6).

Table 5.2: University with no/minimal course work in foreign PhD program

Sl. No	Name of the university	Country	Remarks
1	The University of Newcastle (UON)	Australia	1 scholar
2	University Malaysia Sabah	Malaysia	2 scholars
3	Universiti Malaysia Terengganu (UMT)	Malaysia	1 scholar

Table 5.3: University with no/minimal course work of in-country PhD program

Sl. No	Name of the university	No. of scholars admitted
1	Bangladesh Agricultural University	49
2	Rajshahi University	6
3	Jahangirnagar University	1
4	Patuakhali Science and Technology University, Patuakhali	1
5	Hazi Danesh Science and Technology University, Dinajpur	2
6	Shahjalal Science and Technology University, Sylhet	1
7	Dhaka University of Engineering & Technology, Gazipur	1
8	Sylhet Agricultural University, Sylhet	2
9	Bangabondhu Sheikh Mujibur Rahman Science and Technology University, Gopalganj	1
10	Chittagong Veterinary and Animal Science University	1
Total		65

5.5 Progress of course and research work of overseas and in-country PhD program

5.5.1 Overseas PhD:

More than 89% (in case of developed country 80.61% and 91.30% for developing country) of course work completed by 56 scholars. The overall research work progress was more than 35% (developed country 38.43% and 34.00% in developing country). During the COVID-19 pandemic, 57% of scholars had course work and about 100% had research work. The research and/or course work of all the scholars were affected by the pandemic. Thirty scholars informed that their research work was damaged and need to repeat during the May 2020 survey. The rest of scholars could not perform their research during the pandemic. All universities had been mostly closed since Mid March 2020 to till June 2020. After that some universities opened with alternate entry of student into the lab with a schedule of limited time. Completion of PhD programs is still uncertain due to COVID-19 pandemic situation.

5.5.2 In-country PhD:

More than 71% of course work completed by 43 scholars. The overall research progress was about 46%. During the COVID-19 outbreak, 19 scholars had course work and 72 scholars have research work. All scholars were affected for their research and/or course work. Ten scholars informed that they lost their research work and need to repeat during the May 2020 survey. The rest of the scholars could not perform their research work during the pandemic period. All universities have been closed since 25 March 2020 to date. Completion of PhD program within stipulated time is uncertain because COVID-19 pandemic situation still prevails at home. No one was affected by COVID-19 by June 2020.

5.6 Status of local and foreign training and workshop

NATP-2 project started in financial year 2016-17, so no trainings; workshop was held during the year. During 2019-20 almost 462 scientists received skill development training and 2385 official attended in different national workshop/seminar arranged by PIU-BARC (Table 5.4, 5.7). During organizing the local training programs, the major topic of courses have been selected by PIU-BARC based indications mentioned in the DPP (Development Project proposal. The major courses of local training are: a) Research Methodology b) Administrative and Financial management c) ICT in Agriculture e) Monitoring, Evaluation and Impact Assessment etc.



Research Methodology training assisted the scientists in designing need based researches and to carry out the field research in more efficient way. It also helped them in collecting appropriate data, analysis the collected data to draw inferences and scientific report writing. Similarly the administrative and financial management training organized to develop skill on: strategic planning, good governance, team building, modern office management and tasks, qualities ethics of development managers, administrators, office record keeping, method of communications, correspondence etc.



The training also upgraded the knowledge on resolving personality conflicts, to address negative issues with patience. The scientists learned financial planning process, budgeting, financial reporting, annual accounts, interpreting financial statements, received and payment statements, income and expenditure statement, The scientists also learned different ways of ICT in agriculture like: mobile ICT, GIS in agriculture, e-filing, use of essential software, national portal content management etc. They learned steps of project development, problem analysis, log frame, project proposal writing, project feasibility studies, concepts and rule of project management, scope and stakeholder management, project communication management and project financial management. Tracking of progress is very important in project implementation; scientists attended M&E courses and learned: need for M & E, basic concept of M & E, Log frame in project design, monitoring and evaluation methods and tools, report writing etc.

Total of 3135 participants from 13 NARS institutes were attended in these local training programs and 7122

attended local workshop/seminars. The venues of the local training programs were BARD, GTI, NATA, BAU, BARI and BARC while the duration of local training programs ranged from 2-14 days. The local training improved the skill and attitude of NARS scientists in respect of designing research programs, financial management, leadership & administrative development and use of ICT in agriculture. The execution of training/workshop also improved the capacity of 13 NARS institutes including BARC. Training has changed the institutional efficiency in designing and operation of research programs. Training also brought certain organization benefit like employee satisfaction, stakeholder satisfaction, owner satisfaction and work-forced productivity. Till now 52 officials received foreign training and 59 attended workshop/seminar/study visit at foreign countries (Table 5.4).



Table 5.4: Participants of training and workshop supported by PIU-BARC

Name of event	Number of participant		
	Up to June 2019	2019-20	Total
Local training	2673	462	3135
Local workshop	4737	2385	7122
International training	50	2	52
International workshop/study visit	36	23	59
Total	7496	2872	10368

The following table 5.5 summarized the number of local training courses organized by NARS institutes. The table below showed that BARC as coordinating body organized 48% followed by 11% by BIM, 9% by BARI, 5% by GTI, and less than 5% each by other institutions (Table 5.5). Similarly the training courses offered during 2019-20, BARC as coordinating body organized 60% followed by PIU- and GTI 13% BARD and BLRI 7%, (Table 5.6).

Table 5.5: Sharing of NARS institutions in organizing local training program

SN	Institute	June 2019	2019-20	Total
		# Event organized	# Event organized	# Event organized
1	BARC	35	9	44
2	BARI	8	0	8
3	BIM	10	0	10
4	GTI	5	2	7
5	BARD	3	1	4
6	SRDI	2	0	2
7	PIU	5	2	7
8	BAU/BLRI	3	1	4
9	NATA/BFRI	4	0	4
10	STU Sylhet	1	0	1
Total		76	15	91

Table 5.6: National training

SL#	Name of training	Participant No.	Organized by	Duration (days)
1	Administrative and Financial Management	30	BARC	13
2	Haor adapted Livestock Technology	20	BARC	3
3	Global Plan of action reporting and collection, documentation of plant genetic resources	40	BARC	3
4	Variety profile of potential major crop varieties.	40	BARC	3
5	balanced diet for young children, Pregnant woman and lactating mother	40	BARC	5
6	Sustainable Development Goal	30	BARC	3
7	Monitoring and Evaluation in project Management	29	PIU-BARC	5
8	Skill development on ICT	18	PIU-BARC	5
9	Capacity building of NARS scientist to achieve sustainable development goals (SDG)	30	BARC	3
10	Make the Service easy	40	BARC	2
11	Research Methodology	30	GTI	14
12	Research Methodology	30	GTI	14
13	Training on Report Writing and editing	25	BARC	3
14	Antimicrobial Resistance in Bangladesh	30	Sylhet SAU	3
15	Antimicrobial Resistance in Bangladesh2	30	Rajshahi University	3
Total		462		

Table 5.7: National workshop

SL#	Name of workshop/seminar/meeting	Participant No.	Organized by	Duration (days)
1	Financial Management Workshop	160	PIU- BARC	1
2	Progress Review of In country Ph.D. Scholars	88	PIU	1
3	Progress Review of In country Ph.D. Scholars	110	PIU	2
4	PBRG Annual progress review-Crops	438	PIU	1
5	PBRG Annual progress-AERS	-	PIU	1
6	PBRG Annual progress review-P&E	-	PIU	1
7	PBRG Annual progress review--Fisheries	-	PIU	1
8	PBRG Annual progress review-Livestock	-	PIU	1
9	PBRG Annual progress review-NRM	-	PIU	1
10	Seminar Aquaculture & Fisheries Dev in Bangladesh	200	BARC	3
11	Innovation & Service Process Simplification	50	BARC	3
12	ISM World Bank meeting	78	PIU	1
13	Agricultural Research For Food and Nutrition Security in South Asia: Challenges and Way Forward	100	BARC	1
14	Crop diversification and intensification for food and nutrition security of Bangladesh	400	BARI	1
15	Progress review on Biotechnology research based on biotechnology policy-2012	42	BARC	1
16	Transferable matured technology on safe food production develop by NARS Institute	120	BARC	1
17	Awareness raising meeting against crime	60	BARC	1
18	stakeholder consultation for SDG Progress	80	BARC	1
19	Production and Marketing of tissue culture based planting materials of high value crops	120	BARC	1
20	National Good Governance	39	BARC	1
21	Promoting collective action for strengthening value	300	BARC	2

5.7 International training

In 2019-20 total 2 participants attended foreign training in two countries (Table 5.8). In 2017-18 PIU-BARC, NATP–2 organized one training program on Financial and Office Management at the International Malaysia Education Centre (IMEC), University Malaysia Sarawak (UNIMAS) of Malaysia. In 2018-19 PIU-BARC completed five batches of foreign training, the first one with a group of 6, 2nd one with 2, 3rd one 13, 4th one with 8 and 5th one with 13 participants. In 2019-20 there were two training held in two times in two country. The name of training subjects with participant numbers, duration (days) and country organized are shown in the following Table 5.8. The foreign training improved the skill and attitude of NARS scientists in respect of designing research programs. The execution of training/workshop improved the capacity of 13 NARS institutes.



The foreign training improved the skill and attitude of NARS scientists in respect of designing research programs. The execution of training/workshop improved the capacity of 13 NARS institutes.

Table 5.8: Status of foreign training programs

SL#	Name of training	Participant	Organized	Duration
		No.	by	(days)
1	Vegetables breeding program with special emphasis on Solanaceous Spp	1	USA	14
2	Knowledge Sharing on Challenges for Agro-environmental research	1	Japan	12
Total		2		

Vegetables breeding program with special emphasis on SolanaceousSpp courses was attended by 1 scientist from BARI and Knowledge Sharing on Challenges for Agro-environmental research courses was also from BARI.

Acquire knowledge and skill about tomato and other solanaceous crop's breeding under the project work was conducted at laboratory and greenhouse, Evansdale, WVU, to gain hands-on experience on the techniques for transferring disease resistance trait from *Solanum peruvianum* and *Solanum habrochaites* to cultivated tomato. The whole process, using marker aided selection of progenies through a series of laboratory protocols in USA. He can Learn pest and diseases diagnostics and management protocols under the National Plant Diagnostic Network (NPDN) in WVU, U.S.A.



Acquire knowledge and skill on Challenges for Agro-environmental research in Japan. He shares the knowledge of research in Bangladesh in the training. Share the agro-environmental effect in research in Bangladesh. It may assume that after attending the training courses abroad scientists develop their skill in implementing their researches in the field.

5.8 International workshop/seminar

PIU-BARC, NATP–2 has fund provision for assisting outstanding scientists to attend workshop, seminar, meeting in the foreign countries. As part of the program during 2019-20, the project funded 8 scientists to

participate workshop/seminar in the foreign countries on important scientific issues. As observed from the table below, all scientists attended conferences in Europe, Asia and America. Detailed showed in table 5.9.



Table 5.9: Self-initiative conference/ workshop/ seminar for 2019-20

SL#	Name of conference/workshop/seminar	Participant No.	Organized by	Duration (days)
1	Conference on Performance of Onion advanced lines tolerant to thrips and iris yellow spot virus	1	USA	4
2	Asian Pacific Weed Science Society Conference (APWSS 2019)	1	Malaysia	4
3	Seminar: Risk management in Cotton industry	1	USA	11
4	Multistakeholder partnership meeting of global agenda for sustainable livestock	1	USA	4
5	Conference on Agriculture 2019	1	Thailand	2
6	Conference on veterinary and animal science	1	Malaysia	2
7	IRRDB International Rubber Conference and annual meeting	1	Myanmar	5
8	Conference on Natural Science, Engineering and technology	1	Japan	3
Total		8		

5.9 International study visit

Study visit is another event funded by PIU-BARC for the senior officials of NARS institutes and different ministry. During the year 2019-20 four events were funded where 15 senior officials participated in different countries (table 5.10). The duration of the programs ranged from 9-11 days. Details of the International visit programs funded by PIU-BARC are shown in the following (Table 5.10).



Table 5.10: International study visit in 2019-20

SI #	Title	Participant No.	Country	Duration (day)
1	Food Safety and quality assurance	6	USA	9
2	Meeting on Global Institute for Food Security at Canada	2	Canada	9
3	Ag-Product Processing and Value Addition, Marketing and Mechanization in Agriculture	3	Thailand Vietnam	11
4	Agricultural Research Management	4	USA	9
Total		15		

Chapter 6

Environmental and social safeguard management

The objective of environmental and social safeguard management is to improve environmental and social development and protect land, water, air, biodiversity, peoples and society. Technology generation component of NATP-2 is implementing different types of environmental and safeguard activities keeping in view the pest management plan (PMP), environmental management framework (EMF) and Social Management Framework (SMF) approaches developed and adopted for NATP-2. PIU-BARC has considered environmental and social safeguards as crosscutting issues and have been embedded in the selection processes of CRG and PBRG sub-projects, workshops, monitoring, trainings, field days, etc. The environmental and social safeguards are being applied to all the research sub-projects in different stages of the project cycle. However, a number of environmental and social safeguard management activities have been undertaken by the component as follows:

6.1 Environmental and social safeguard management activities performed under CRG and PBRG sub-projects

6.1.1 Overall activities performed under CRG and PBRG sub-projects

A number of environmental and social safeguard activities have been undertaken by the component since the inception of NATP-2. All the awarded CRG and PBRG sub-projects addressed environmental and social safeguard issues like bio-diversity (Flora, fauna, genetic diversity, hybrids), soil quality (Organic matter, chemical fertilizer use, soil salinity, fertility status, microbial activity, heavy metal contamination, water quality), agro-chemicals (Pesticide use, pest infestation, bio-pesticides, health hazard) and pollution (Soil, water, air) directly or indirectly to improve environmental and social development through sub-project interventions. The results of most of the CRG sub-projects showed positive impacts on environmental and social development. As observed 18 CRG sub-projects addressed environmental issues bio-diversity, mangrove eco-system, agro-forestry and water management, 29 addressed climate change impacts, 7 identified varieties suitable for coastal, hill, haor/beel, barind tract, Madhupur Tract and monga regions and 7 focused on environment friendly farming techniques. Among PBRG sub-projects 5 addressed environmental aspects (bio-diversity and agro-forestry), 3 focused on environment friendly integrated farming systems, 3 dealt with improvement of charland and coastal ecosystems and 01 dealt for use of solar pump for surface water irrigation, 01 for improvement of soil quality & soil health and 09 on food safety issues. All the awarded CRG and PBRG sub-projects addressed environmental and social safeguard issues directly or indirectly to improve environmental and social development through sub-project interventions. These sub-projects were designed to develop sustainable production practices of crops, fisheries and livestock leading to end with environment friendly and climate smart innovative technologies. Hence, most of the sub-projects under CRG and PBRG are not only environment friendly but also improving the environment of the project areas. All the information generated through the research component and disseminate to extension components will enhance crop, livestock and fisheries production in the country through promoting environment friendly technologies which is available in the website (www.natpbarc.gov.bd) and other publications of PIU-BARC, NATP-2.

6.1.2 Information on CHT related researches under CRG and PBRG sub-projects

Publicly disclosed the research information on CHT region under CRG and PBRG sub-projects as agreed

actions of ISM3 through publishing in the PIU-BARC website (www.natpbarc.gov.bd) of NATP-2 for quick dissemination of useful scientific information/technologies for the betterment of the farmers in the CHT region. In view of diversities and potentialities prevail in Chattogram Hill Tract (CHT) consisting of three hilly districts of Bangladesh: Rangamati, Khagrachari and Bandarban districts, PIU-BARC, NATP-2 awarded 14 CRG sub-projects (Table 6.1) implemented by different organizations in CHT districts and 6 PBRG sub-projects/components those have been implementing in CHT region to develop location specific technologies to address different aspects of agricultural production to improve the livelihoods of the farmers of the different tribal communities/Jhumia community (Shifting cultivators)/Indigenous People (IP) living in these areas.

The fourteen (14) CRG sub-projects (Table 6.1) were implemented in the CHT region covering collection, conservation, maintenance and documentation of different fruits including minor fruit germplasms, supply chain analysis of vegetables produce, agricultural practices and livelihood pattern of selected tribal communities, agroforestry for livelihood development of Jhumia community, development of rice-cotton based agroforestry, production enhancement of carps and tilapia in creeks, different IPM technologies, dragon fruit production, improvement of spices varieties (cumin, sweet pepper, chilli, turmeric, black pepper), development of shelf stable value added products (from onion, garlic, ginger), and potentials of fish production technologies and policies. Thirty two indigenous germplasm of 12 fruits have been collected from different location of CHT. Eight indigenous germplasm of 6 fruits have been identified and collected from different locations of Khagrachari. The minor fruit germplasms of five Monkey jack, eight Velvetapple, four Cowa, three Riverebony and one each of Governor's plum, Lukluki and Gutguti genotypes have been identified. Thirty three germplasm of spices have been collected. Vegetable production techniques in hilly areas have been identified and vegetables cultivation found profitable there. Tribal farmers have been engaged in agriculture as well as other income generating activities where majority of them produced agricultural commodities. The most common farming practices, agricultural technologies and constraints have been identified. Limited knowledge on agro-forestry practices; in-adequate availability of quality saplings, fertilizer and pesticides; scarcity of water and uncertainty of market price of farm products have been identified as major problems of hill farmers in agro-forestry. 12 hectares bamboo plantation has been established in the farmers, field with other agro-forestry species of timber, fruits and year round vegetables. Inter-Cropping of Rice and Cotton with Banana/Papaya has been found more profitable than Jhum crops. Fish production technology in the creeks has been adopted by the people of CHT districts. For Lake Fishery, overfishing, illegal gear fishing, pollution by agriculture practice should be controlled through implementing fish act and awareness and ecosystem based management. IPM technologies have been developed against fruit fly for different fruit crops, jassid population and white fly population. Off-season production of dragon fruit has been made possible by manipulating the environment through artificial lighting using 100-watt incandescent bulb (normal bulb), 20-watt LED (Light Emitting Diode) bulbs or 36-watt CFL (Compact Fluorescent Lamps). The optimum NPK requirement for the cotton varieties CB-14 and CB-15 has been found 175, 80 and 200 kg/ha respectively. High quality shelf-stable onion, garlic and ginger products have been developed by utilizing available low cost dehydration processes and post-harvest losses of these spices have been reduced to an acceptable level.

Six PBRG sub-projects (Table 6.1) have been executing in CHT regions covering transfer of agricultural technologies to farmers' level; household food security, income generation and minimize malnutrition; development of lean season fruit varieties and management packages; adaptation and scaling up

agroforestry; and exploration, identification, characterization, multiplication and ex-situ conservation of endangered forest genetic resources including medicinal plants and other important plant genetic resources. The four recently generated technologies by CDP: i) CB-14 variety, ii) application of mepiquat chloride iii) removal of vegetative branches and iv) De-topping at 90 DAS (Day after sowing) were tested at Bandarban site and found more profitable and increase per hectare yield. The technological interventions made by BLRI component: distribution of goats, sheep, winter vegetables seeds and saplings, different seasonal vegetables (capsicum, broccoli, potato, sweet potato, yard long bean, sweet gourds etc.), year round creeper vegetables (cucumber, bitter gourd, bottle gourd etc.), and fruit orchards for year round fruit production (papaya, lemon, malta, dragon) to the selected household in Khagrachari. This food-based initiative has been improving nutrition for household food security with a long-term goal for sustainable improvement of food and nutrition of the rural poor. Collection, characterization and evaluation of the promising lean seasoned fruit germplasm at BARI Hill Agriculture Research Station, Raikhali such as 3 germplasm of bullock's heart, 2 of pear and 1 each of ber, pummelo, pear, strawberry, avocado and mango were made and planted in the research field. In hill ecosystem, agroforestry (contour hedged grows) on steep hill slopes (40-50%) can reduce soil erosion by 55-80% and runoff by 30-70% compared to shifting cultivation. Different agro-forestry systems are being conducted under Bandarban. Fruit/seed of 25 threatened tree species including medicinal plants were collected for recording of phenological characteristics and transferred to the conservation stands a CU campus for improving Forest Genetic Resources and biodiversity of the country. 25-36 seedlings of each species were planted in the pre-selected site after clearing, burning and proper soil work. Collection, characterization, conservation and documentation of popularly grown crops with a view to establish IPR (Intellectual Property Right) is being done under the sub-project (ID 128). BARRI collected 103 landraces of rice from 7 Upazilas of Bandarban. BAU completed morphological characterization of 62 indigenous germplasm of banana, 30 yam and 30 aroids. The germplasm collection of more than 18 different crops by participating research institutes was 651 against the target of 570. Besides, from personal communication it is known that 15 lean season fruit germplasm collected from Rangamati for conservation and characterization for further trial, 98 ethno-medicinal plants germplasm were collected from CHT, BSRI collected 11 sugarcane germplasm from hill districts, some of the jhum rice varieties are pidi, mongbui, mongthong, etc. Training, motivation, support and extension services of different government and non-government organizations might raise the awareness about modern agricultural technologies for increasing the agricultural production as well as improving the livelihoods of the farmers in the region.

Table 6.1: List of 14 CRG and 6 PBRG sub-projects implemented in CHT region

Fourteen (14) CRG sub-projects implemented in CHT region	
1	Sub-project: Collection, conservation and maintenance of different fruits germplasm in the hilly region of Bangladesh (ID # 783)
2	Sub-project: Supply chain analysis of major vegetables produce in hill and coastal regions of Bangladesh (ID # 407)
3	Sub-project: Agricultural practices and livelihood patterns of selected tribal communities in Bangladesh (ID # 454)
4	Sub-project: Agro-forestry for livelihood development of jhumia community (shifting cultivators) in Chittagram hill tracts, Bangladesh (ID # 386)

5	Sub-project: Development of agro-forestry model for conversion of rice–cotton based hill farming system in the Chattogram hill tracts (id 582)
6	Sub-project: Production enhancement of carps and tilapia in creeks of Chattogram hill districts (ID # 833)
7	Sub-project: Characterization and documentation of minor fruits in Bangladesh with special emphasis on coastal and hilly areas (ID # 384)
8	Sub-project: Studies on the species complex and their bio-rational based management of fruit flies infesting fruits and vegetables in Bangladesh (ID # 526)
9	Sub-project: Development of production package with special emphasis on off season flowering of dragon fruit (ID # 538)
10	Sub-project: Development of eco-friendly management of sucking insects of cotton (ID #584)
11	Sub-project: Improvement of spices varieties cumin, sweet pepper, chilli, turmeric and black pepper through induced mutation (ID # 804)
12	Sub-project: Effect of variety and fertilizer on cotton yield, fiber quality and seed oil contZnt. (ID # 791)
13	Sub-project: Development of shelf stable value added products from onion, garlic and ginger (ID # 728)
14	Sub-project: Potentials of modernization in fisheries sector of Bangladesh: study on the peoples' profile, technologies and policies (ID # 648)
Six (6) PBRG Sub-projects/Components implemented in CHT region	
1	Sub-project: Transfer of Agricultural Technologies to Farmers' level for Increasing Farm Productivity (ID # 005)
2	Sub-project: Food-based initiative for improving household food security, income generation and minimize malnutrition (ID # 011)
3	Sub-project: Development of lean season fruit varieties and management packages (ID # 013)
4	Sub-project: Adaptation and Scaling up Agroforestry for Livelihood Improvement of farmers in Agricultural Ecosystem of Bangladesh (ID # 049)
5	Sub-project:Exploration, Identification, Characterization, Multiplication and <i>Ex-situ</i> Conservation of Endangered Forest Genetic Resources including Medicinal plants of Bangladesh(ID # 074)
6	Sub-project: Collection, Conservation and Characterization of Important Plant Genetic Resources (ID # 128)

6.1.3 Food and nutritional security addressed through CRG and PBRG Sub-projects

Food and nutritional security is achieved, if adequate food (quantity, quality, safety, socio-cultural acceptability) is available and accessible for and satisfactorily used and utilized by individuals at all times to live a healthy and active life. Food safety is about handling, storing and preparing food to prevent infection and help to make sure that our food keeps enough nutrients for us to have a healthy diet. Food safety threats in Bangladesh are arsenic in food, adulterated food, genetically modified food, environment pollutants in food, human-induced food adulteration during farm production, industrial production, marketing, and street food vending, etc. Food & nutritional security is also very much important to sustain the development of the country. In view of these, As NATP-1 NATP-2 also working on food and nutrition security, particularly PIU-BARC undertook several CRG and PBRG sub-projects related to food and nutritional security. In fact, though most of the CRG and PBRG sub-projects addressed to ensure food and nutritional security/safety issues directly or indirectly through sub-project interventions. However, 33 CRG sub-projects were awarded to address different aspects of food and nutritional security/safety issues and 28 PBRG sub-projects were awarded to

ensure the overall food & nutritional security/safety issues. Food & nutritional security/safety issues are being adequately addressed through improving crop, livestock and fish production in terms of quality and quantity.

6.1.4 Ex-Act data questionnaire and climate co-benefit

Any agricultural technology is usually tested before its release whether technology is economically viable, socially acceptable and environmentally sound. Technology should be climate resilient/climate smart, a new ideas in now-a-days. All the CRG and PBRG sub-projects can be classified into three groups such as (i) climate-neutral, (ii) having climate co-benefits and (iii) direct climate-related. Ex-Act Data Questionnaire can be used for some of the CRG and PBRG sub-projects when required data would be available. It is mentioned that there are:

- At least 27 CRG sub-projects and 6 PBRG sub-projects are related to climate/co-benefits.
- Out of 80 local PhD scholars have 16 and out of 60 foreign scholars have 11 research topics are related to climate adaptation, resilience/ or mitigation in agriculture.

6.1.5 The type and extent of climate-smart agriculture activities

Climate-smart agriculture (CSA) may be defined as an approach for transforming and reorienting agricultural development under the new realities of climate change (Lipper et al. 2014). The most commonly used definition is provided by the Food and Agricultural Organization of the United Nations, which defines CSA as “agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals”. In this definition, the principal goal of CSA is identified as food security and development (FAO 2013a); while productivity, adaptation, and mitigation are identified as the three interlinked pillars necessary for achieving this goal. Key characteristics of CSA are CSA addresses climate change, integrates multiple goals and manages trade-offs, maintains ecosystems services, has multiple entry points at different levels, context specific and engages women and marginalized groups. Key characteristics of CSA are CSA addresses climate change, integrates multiple goals and manages trade-offs, maintains ecosystems services, has multiple entry points at different levels, context specific and engages women and marginalized groups. In view of these, all the CRG and PBRG sub-projects could be related to pillars and key characteristics of CSA since any agricultural technology is usually tested before its release whether technology is economically viable, socially acceptable and environmentally sound. Technology should be climate-smart agriculture, a new initiative in now-a-days. All the CRG and PBRG sub-projects can be classified into three groups of agricultural interventions such as (i) climate-smart, (ii) partially climate-smart and (iii) climate-neutral. In view of pillars & key characteristics of CSA there are at least 17 CRG sub-projects and 6 PBRG sub-projects are related to climate-smart agriculture. Most of the technologies developed under CRG sub-projects which are also related to CSA.

6.2 Field monitoring on environmental and social safeguard management

Field monitoring was done on 6 PBRG sub-projects conducted in 8 locations (8 components) in the districts of Sirajganj, Pabna and Rajshahi during December 2-5, 2019, one PBRG sub-project ID # 128 at Cotton Development Farm at Jagodishpur, Chougasa, Jashore on 28 February 2020 and 6 PBRG sub-projects conducted in 10 locations over Sylhet and Moulvibazar districts during 9-12 March 2020. Collected required data on overall experimental status and gave suggestions regarding environmental and social safeguard issues. The overall sub-project activities were shown satisfactory. Visited laboratory, green house and experimental fields have shown neat and clean. All PI/Co-PIs have shown keen interest to implement environmental and social safeguard issues including gender and IP issues (if applicable). The CDB farm is quite big sized having area of 63.7 ha (157 acres). Observed the performances of different germplasms multiplied

in the field hopeful to increase cotton production substantially in the country expecting cotton yield of 5-6 t/ha from the germplasms collected from Turkey. Visited PBRG sub-projects along with Environmental and social safeguard issues addressed are shown in Table 6.2. Recommendations as follows:

- For the sub-project 097 activities should be further extrapolated particularly year round vegetable production using Gopalganj model and sunflower cultivation
- For the sub-project 035, establishment of sanctuary, mala and dhela production in the pan and then releases in water to enhance small fish production and fish production in the case with Pangus, magur and pabda species should be popularized.
- For the sub-project 138 the data on heavy metal should be collected in addition of the antimicrobial resistance and residues in Livestock and Poultry food products and feeds.
- For the sub-project 072 more germplasms of tea germplasms are to be collected from different tea estates in the region, focused to be given to BTRI.

Table 6.2: List of PBRG sub-projects visited with environmental and social safeguard issues addressed along with sub-project Title & ID.

SN	Title of PBRG sub-projects with ID	Environmental and social safeguard issues addressed
	Sirajganj-Pabna-Rajshahi region	
1	Transfer of agricultural technologies to farmers' level for increasing farm productivity (ID 005, 3 Components- BFRI, SRDI & BRRI)	Additional nutrition to be provided to farmers through increased fish production and livelihoods of farmers to be improved due to increased production of HYV rice using balanced fertilizer. Fish Ponds and rice fields were well managed.
2	Improvement of farm productivity through intervention with improved agricultural technologies in char land eco-system; ID 096 (P&E)	Livelihoods and nutrition of farmers of the locality to be enhanced through implementing agro-forestry and homestead gardening. Vegetation and carbon sink to be improved.
3	Techniques adoption and formulation of guidelines for sustainable management of Haor and Beel fisheries (ID-035, RU-Location Sirajganj)	Biodiversity will be conserved and socio-economic condition of fishers will be improved.
4	Collection and characterization of important plant genetic resources (ID-128, BSRI-Ishurdi, BSTRI-Rajshahi)	Biodiversity will be conserved.
5	Improvement of existing fattening technology of carp and high valued small indigenous species (SIS) through good aquaculture practices (GAP) in different agro-ecosystems (ID-037, RU-Rajshahi).	Biodiversity will be conserved. Socio-economic environment of fishers will be improved through increased fish production.
6	Determination of antimicrobial resistance and residues in livestock and poultry food products and feed in Bangladesh (ID-138, RU-Rajshahi)	Food safety will be improved in the country.

7	Collection and characterization of important plant genetic resources (ID-128, CDB component at Jagodishpur, Chougasa, Jashore	Biodiversity has been conserved through collection of cotton genotypes particularly from Turkey.
Sylhet and Moulvibazar region		
8	Techniques Adoption and Formulation of guidelines for sustainable management of Haor and Beel Fisheries (ID 035)	Fish production increased and biodiversity of fishes is conserved.
9	Germplasm conservation and farm productivity enhancement through the interaction of shade trees and tea based agroforestry system to mitigate the climate change (ID 072)	Biodiversity has been conserved; farm productivity and carbon sink will be increased.
10	Livelihood Improvement of Farmers through Integrated Farming System Research and Development of Drought and Rainfed Ecosystem (ID 097)	Farmeres livelihoods and drought and rainfed ecosystem will be improved through integrated farming system research.
11	Development of knowledge hub on Animal Feed resources for efficient feeding management of ruminants to enhance productivity (ID 108)	Ruminants productivity will be increased through efficient feeding management with development of knowledge hub on animal feed resources.
12	Determination of Antimicrobial Resistance and Residues in Livestock and Poultry Food Products and Feed in Bangladesh (ID 138)	Food safety will be improved through determining antimicrobial resistance and residues in livestock and pultry food products and feed.
13	Analysis of agricultural policy on food system and rural development in Bangladesh: Case of Haor area (Wetland) Management Practice (ID 158)	Fish biodiversity and livelihoods of fishers will be improved through higher fish production by applying better management practices

6.3 Gender strategy

PIU-BARC always encourages women participation in all the activities undertaken in the unit as equal opportunity basis. Many female farmers in the project areas are also involved in project activities particularly in training programs, workshops, field days, etc. CRG and PBRG research programs have created ample opportunities for economic development; identify special requirements for enhancement of women activities, power sharing and leadership opportunity through women participation in the project. Women friendly technologies have also developed through these programs. No problem faced by women in the project. Hence, mainstreaming of women is progressing through project activities. Environmental and social safeguards, gender issues have been have been duly addressed by the major interventions of the PIU-BARC. The compliance of gender issues by the major activities of the component is stated below:

- Out of 190 CRG sub-projects 7 were related to address women friendly/women empowerment
- 4 PBRG sub-projects are identified related to women friendly/women empowerment
- 190 CRG sub-projects had 22 PIs were women (12%)
- It is observed that 9 PBRG sub-projects are being operated by women coordinators (out of 51 coordinators i.e. 18%) and 11 women scientists working as PI (out of 139 PIs i.e. 8%)
- Out of 140 research topics of 140 PhD scholar's (local and foreign), 2 topics are found related to

women friendly/women empowerment

- Women scholars are 34% under local PhD programs, 13% in foreign PhD and overall 25% in total PhD scholarship
- Out of 3016 local trainees 599 and out of 52 foreign trainees 2 were women trainees.

6.4 Indigenous people (IP) strategy

Putting importance to IP population, six CRG sub-projects were conducted in the CHT areas, 02 in Modhupur Tract area (Mymensingh), 02 in Sylhet region and 01 in Barind Tract area (Rajshahi/Chapai) to address different aspects of agricultural production. The CRG sub-project (ID-454) entitled “Agricultural practices and livelihoods patterns of selected tribal communities in Bangladesh” depicted overall picture of IP community in terms of production potentials, constraints and mitigation measures. Several CRG and PBRG sub-projects were conducted on varietal adaptation trials trying to identify varieties suitable for these regions. The information generated through these sub-projects should be disseminated to extension components which will enhance crop, livestock and fisheries production in the hilly and IP living regions.

6.5 GRM management

PIU-BARC, NATP-2 is implementing all the project activities with transparency, accountability, risk reduction and effective way along with adopting Grievance Redress Mechanism (GRM). In this regard, following actions have been undertaken:

- Dr. Md. Harunur Rashid, Director PIU-BARC, NATP-2 is acting as Grievance Redress Officer (GRO) and Dr. Md. Abdus Salam, Member-Director (P & E), BARC is acting as Appellate Officer (AO) to action taken against any suggestion or complain submitted by any stakeholder of the PIU-BARC, NATP-2. Besides, there is a provision in PIU-BARC website (www.natpbarc.gov.bd) to lodge complain or constructive suggestion by any stakeholder to implement GRM in the component. Names, addresses, telephone number of GRO and AO are also placed in the website of PIU-BARC, NATP-2.
- A complain box has been placed in office premise of PIU-BARC, NATP-2, BARC, Farmgate, Dhaka-1215.
- In the office premise of PIU-BARC a registrar notebook has been kept for record keeping to write complain/suggestion by stakeholders.

It may be mentioned here that no suggestion or complain has been received during the reporting period of PIU-BARC 2019-2020, NATP-2.

6.6 Implementation, coordination and institutionalization

Implementation, coordination and institutionalization are the key factors for success and sustainability of any project activity. In view of this, PIU-BARC organized a series of workshops on implementation process, annual research progress, annual monitoring progress, technology dissemination, etc. of CRG and PBRG sub-projects. In the Implementation process workshops of CRG & PBRG sub-projects, all the Coordinators / PIs / Co-PIs have been advised to follow the environmental and social safeguard implementation guidelines in the sub-projects. In the inception workshops of 11 PBRG sub-projects, all the PIs and Co-PIs were being advised to follow the environmental and social safeguard implementation guidelines in the sub-projects. Recommendations implemented which were adopted in the day-long specific workshop with 72 participants from NARS institutes, universities and extension agencies (DAE, DoF and DLS) was organized on 12 Feb 2019 by PIU-BARC, NATP-2 to build awareness on the Environmental and Social Safeguard issues with .Two training programs were organized on Integrated Pest Management (IPM) with a batch of 30 participants from NARIs summing 60 participants. The workshops have sensitized the stakeholders and participants. Environmental and social safeguard management issues have been institutionalized through the focal persons of the

research proponent institutes/organizations where research proponents were acted as focal persons.

6.7 Environmental and social safeguard compliances

Reviewed and verified 11 PBRG sub-projects covering different aspects of crop, livestock and fisheries showed satisfactory compliance with safeguard measures based on exclusion criteria and environmental screening matrix. PBRG sub-projects were selected on competitive basis following the guidelines described in AIF-1 and Project Implementation Manual (PIM). All the sub-project activities were performed in transparent way. Moreover, observations reveal that any PIU-BARC activity under PBRG sub-projects covering crops, livestock and fisheries does not involved in land acquisition, involuntary resettlement, encroachment of reserve forests, and use of prohibited pesticides, etc. No complain has been received from any one either from female or male working under the sub-projects and any other stakeholder of the project due to any activity of the component. Finally, all the Coordinators/ PIs/Co-PIs are aware of environmental and social safeguard management than before. The above information reveals that all the project activities of PIU-BARC implemented in the reporting year are met with total compliances to environmental and social safeguards.

Chapter 7

Monitoring and evaluation

Monitoring and Evaluation (M&E) improves the implementation performance and helps to achieve results. Monitoring is a continuous collection of data on specified indicators to assess development intervention (project, program or policy). While evaluation is the periodic assessment of the design, implementation, outcomes and impact of development project. Desk Monitoring reviews financial, physical and technical progress of a project. While field monitoring usually conducted at an interval of 5-6 months using a given format to capture firsthand information/data.

PIU – BARC has taken enough steps to monitor the field progress of PBRGs. It has established central M&E Cell at BARC, Divisional M&E Cell of BARC, institutional M&E Cell at respective organizations and formed PIU-BARC Monitoring Team to make desk and field monitoring of on-going PBRG sub-projects. Details of the monitoring systems of PIU-BARC specially, the process of different cells formation in BARC and institute levels has been detailed out in the earlier Mission Reports.

7.1 Desk monitoring: it includes:

- Review of half-yearly reports: As per PBRG operational guidelines each of the PIs are to submit half-yearly reports of research sub-projects, which to be accepted by the respective divisions of the BARC. And submission and approval of half-yearly reports by the respective divisions of the BARC is the prerequisite for release of next installment of project fund from PIU-BARC. The monitoring section of the PIU-BARC review the submitted half-yearly reports following a checklist prepared following the half-yearly reporting format. If any deviation or lacking or shortage of data interpretations is recognized by the monitoring officials in the report it send back with the comments and request for submitting revised report. PIU-BARC send the reports to the respective divisions for approval and required fund release. This is an on-going process.
- Review of annual reports: The procedure stated for half-yearly reports followed for the annual reports and recommended for fund release of next quarter. On-going process of PIU-BARC.
- Progress review workshop: This is an annual event conducted in the BARC auditorium after the end of the fiscal year generally during Aug-Sep. The annual progress review workshop on PBRG sub-projects was held during 16-20 Nov 2019 at BARC conference room -1. The Executive Chairman of the BARC Dr. Kabir Ekramul Haque chaired the inaugural session of the workshop. The Director of the PIU-BARC, NATP –2 including all Member Directors (MD) of BARC were present in the inaugural session. All the PIs and Co-PIs of 40 (155 components) PBRG sub-projects including the expert members and consultants/officials of BARC were present in the workshop. In addition 8 expert members in different disciplines were present who contributed to improve the field implementation of the research projects. Some of the important recommendations are summarized below. The detailed recommendation duly sent to the PIs by the monitoring section of the PIU-BARC.
- ID # 128: Germplasm list for hilly region including wild type Germplasm should also be put importance
- ID # 128: Qualitative and Quantitative data should be added for new sample and duplication should be avoided for molecular characterization of desirable crops
- ID # 128: Morphological and molecular characterization should be completed within sub-project period by keeping one column for lesson learned
- ID # 005: In technology transfer study, checked variety should always be there against the introduced variety, BCR or cost benefit analysis of each technology should be shown
- ID # 005: Technology factsheet with technology name, brief description, utility, yield, area to be produced

and supplied to farmers

- ID # 013: Result of soil test data of experimental field and BCR should be added in report. Presentation of slides should include methodology
- ID # 054: Parameters for measuring livelihood improvement should be added in the activity part
- ID # 098: Women involvement should be increased and findings should be mentioned regarding distribution of poultry, duck and other livestock
- ID # 077: The updated findings of the project by components within the reporting period should be mentioned
- ID # 074: The list of endangered medicinal spp. as well as forest genetic resource (FGR) and its' existing condition to be classified in the report preparation

7.2 Field monitoring

Field monitoring of the research sub-projects is generally done by forming a team with multiple number of experts from different disciplines. In last fiscal year 2018-19 the P & E division of BARC formed 10 monitoring teams mostly headed by MDs of BARC. Field monitoring of PBRG sub-projects conducted by the monitoring team of the Technical Divisions of BARC and PIU-BARC, NATP-2 using prescribed format during Feb to May 2019. Out of 118 components of PBRG sub-projects assigned, 76 components had monitored by the monitoring teams. The monitoring reports and presentation of the team observed that the implementation progress of almost all the sub-projects are satisfactory.

7.3 Field monitoring workshop

The Project Implementation Unit (PIU), Bangladesh Agricultural Research Council (BARC), NATP-2 organized a two day long workshop on Monitoring of PBRG (Program Based Research Grant) sub-projects at BARC auditorium from 17-18 June 2019. All concerned PIs and Co-PIs were present in the workshop. The team leader of the monitoring team presented their monitoring findings by sub-projects visited. The remarks and comments of participants including the invited expert members were captured by the rapporteurs and compiled by the M & E section of PIU-BARC. The major recommendations of the workshop for the PIs are:

- 1) The Principal Investigator (PI) should bear the full responsibility of showing the field progress of PBRG sub-projects during monitoring visit of the Team
- 2) Sub-project output should be relevant with the objective
- 3) Financial reporting, cash book, register etc. should be maintained properly and monitored
- 4) Expenditure to be made in accordance with the line items
- 5) Project ID # 005: This project title could be changed to adaptive trial or on farm trial instead of transfer of agricultural technologies
- 6) Farmers' feedback should be recorded for adopting new technologies
- 7) Research extension linkages should be maintained with visible evidences
- 8) Findings of farming system research and time of seed distribution should be mentioned (ID 098)
- 9) The crab should be collected from nature as well as farm (Objective 2 of ID 029)
- 10) Distribution of Pigeon should be stopped as per farmers' opinion
- 11) Justification is needed for avoiding duplication with KGF project under objective 3, 4 concerning the project ID-064
- 12) Activity of poverty alleviation should be mentioned (ID 098)

- 13) After radiation treatment the variety for stress evaluation should be planted in specific locations
- 14) Control plots are to be taken for comparison of farm productivity
- 15) Economics or BCR should be calculated for each of the farming systems sub-projects/experiments

7.4 Monitoring team

For 2019-20 fiscal year, the Director PIU-BARC formed 09 teams to monitor all the components of PBRG sub-projects. It was planned that the monitoring team made field visit from Oct 2019 to Mar 2020. As per plan monitoring workshop to be organized in June 2020 (COVID – 19 made it pending) where the findings are to be presented by the leader of each of the team. The monitoring team with their allocated regions and projects are shown in the table 7.1.

Table 7.1: Field monitoring team for 2019-20

Region	Project ID	Team member
1. Barishal (Barishal&Patuakhali)	PSTU(Barishal)-007, 036, 138 PSTU(Patuakhali)-037	1. Dr. MianSayeedHasan 2. Dr. M. N. Ali Sarder 3. MunshiMamunur Rahman
2. Dhaka (BLRI, BJRI, SAU, DU and SSURDA)	DU-010, 016, SSURDA- 026, BLRI-096, 108, 110, 138, 139, BJRI-128, CDB-128, SAU-135	1. Dr. M. A. JalilBhuyan 2. M. Abdullah Al-Faroque 3. Md. Abdur Rahman
3. Gazipur (BARI, BRRI, BSMRAU)	BARI- 001, 002, 005, 013(3), 016(3), 021, 026(3), 049(3), 054(2), 061, 087, 096, 098, 099, 103, 128, 134, 135; BRRI- 091(2), 099, 128, 134, 135; BSMRAU- 135	1. Dr. M. A. JalilBhuyan 2. Dr. M. N. Ali Sarder 3. M. Assaduzzaman 4. Monir A. Khondoker
4. Chattogram (Chattagram, CHT, Cox' bazaar and Noakhali)	CDB- 005(Bandarban), NSTU- 011, BLRI (Khagrachari)-11 BFRI (Forest)-074, CU-074, CVASU- 138, BFRI (Fish)- 031	1. Dr. M. N. Ali Sarder 2. Md. AbdurRahaman 3. Dipok Kumar 4. Md. Hasan Mahmud
5. Khulna (Khulna, Bagerhat, Satkhira, Jashore)	Paikgacha-029, Bagerhat-029, KU-029, 031, BFRI (Bagerhat)- 031, BRRI (Satkhira)-098, CDB (Jashore)-128	1. Dr. M. N. Ali Sarder 2. MunshiMamunur Rahman 3. Md. Hasan Mahmud
6. Mymensingh (Mymensingh and Jamamalpur)	BAU- 030, 036, 054, 070, 074, 077(2), 091, 099, 108, 128, 134, 135, 138, 139; BINA- 002, 005, 021, 089(4), 096, 098, 110, 128, 134, 135; Jamalpur- 077	1. Dr. MianSayeedHasan 2. Dr. M. A. JalilBhuyan 3. M. Abdullah Al-Faroque 4. M. Ashiqur Rahman
7. Rajshahi (Rajshahi, Pabna, Sirajganj, Bogura, Natore)	RU- 035, 037, 138, BSRTI- 128; BSRI- 05, 096, 128, BARI- 054; BLRI (Sirajganj)- 096	1. Dr. Md. Serajul Islam 2. Dipok Kumar 3. Md. Abdur Rahman
8. Rangpur (Rangpur, Dinajpur, Thakurgaon, Panchagarh)	Dinajpur: HSTU- 007, 138; BWMRI- 005 Rangpur: BRRI- 002, CDB- 002 (Rangpur&Thakurgaon), BJRI- 005, BARI (OFRD)- 054, 061	1. Dr. M. N. Ali Sarder 2. Md. Abdur Rahman 3. Dipok Kumar
9. Sylhet (Sylhet and Moulvibazar)	SAU-Sylhet- 035(2), 072, 108, 138; BTRI- 072	1. Dr. Md. Serajul Islam 2. Md. Abdur Rahman 3. Dipok Kumar

Till March 2020, five regions: Chattogram (Chattagram, CHT, and Noakhali); Mymensingh (Mymensingh & Jamalpur); Rangpur (Rangpur, Dinajpur, Thakurgaon, Panchagarh); Rajshahi (Rajshahi, Pabna, Sirajganj, Bogura, Natore); Sylhet Region (Sylhet, Moulovibazar) were covered out of 9 planned and due to COVID-19 the other teams could not make field visit. The monitoring workshop is yet to be organized. However, the M & E Specialist submitted the monitoring report to the Project Director after each of the visits.

The preliminary findings of those field visits are summarized below:

SL No.	Region	Project ID	Recommendation
1	Chattogram(Chattagram, CHT, and Noakhali)	005, 011, 074 and 128 (27 to 31 Oct 2019)	<ul style="list-style-type: none"> - Sub-project 011: Nutritional data is suggested to be collected from the supported and non-supported group along with the dietary data - They have not yet started collecting nutritional data then how would compare before after project situation for people who receive support from the project - So nutritional data collection should be started as early as possible - Sub-project 128: Data on heavy metal should be collected in addition of the antibiotic residues as they do have the ready samples of blood, milk, egg, meat etc. 
2	Pabna and Rajshahi	096, 035, 096, 128, 005, 037, 138, 054 (02 to 05 Dec 2019)	<ul style="list-style-type: none"> - For farming system research Project ID 097: Before and after project data would be needed for cooperators for valid comparison - Control data to be collected also from neighboring hh to compare the livelihood development - Sub-project 128: Data on heavy metal should be collected in addition of the antibiotic residues as they do have the ready samples of blood, milk, egg, meat etc. 

3	Rangpur (Rangpur, Dinajpur, Thakurgaon, Panchagarh)	020, 054, 096, 061, 089, 002, 049, 064, 151, 138, 005, 013, 072, 151 (18 to 23 Jan 2020)	<ul style="list-style-type: none"> - Sub-project 054: High level monitoring team should visit the farming system sites of Lalmonirhat and Kurigram for further extrapolation of the technologies - Sub-project 005: Mechanical seeder for wheat should be improved or operators are to be well trained - Sub-project 128: Data on heavy metal should be collected in addition of the antibiotic residues as they do have the ready samples of blood, milk, egg, meat etc. - Sub-project 013: For Debigonj farm more germplasms of lean-seasoned fruits are to be collected from nearby areas, focused to be given to Horticulture Center (DAE) and private nurseries for collecting variable germplasms including exotic ones 
4	Sylhet (Sylhet, Moulvibazar)	035, 072, 097, 108, 138, 158 (9- 12 Mar, 2020)	<ul style="list-style-type: none"> - For the sub-project 097 activities should be further extrapolated particularly vegetable production using Gopalganj model and sunflower cultivation. - For the sub-project 035, establishment of sanctuary, mala and dhela production in the pan and then releases in water to enhance small fish production and fish production in the case with Pangus, magur and pabda species should be popularized. - For the sub-project 138 the data on heavy metal should be collected in addition of the antimicrobial resistance and residues in Livestock and Poultry food products and feeds. - For the sub-project 072 more germplasms of tea germplasms are to be collected from different tea estates in the region, focused to be given to BTRI. 

5	Mymensingh (Mymensingh & Jamalpur)	005,030,061, 103, 089, 096, 110, 128, 134 & 135	<p>Sub-project ID: 005</p> <ul style="list-style-type: none"> - Environmental and social safeguards are being well addressed through increased fish production and providing additional nutrition to farmers - Sub-project Component personnel are advised for frequent visit to the demonstration sites  <p>Sub-project ID: 103</p> <ul style="list-style-type: none"> - Component personnel are advised for frequent visit to the experimental sites.  <p>Sub-project ID: 089</p> <ul style="list-style-type: none"> - Line sown mustard field need to be thinned as well as fungicide should be sprayed to control diseases - Component personnel are advised to identify the diseases of the infected plants as well as advised to frequent visit the mustard fields.  <p>Sub-project ID: 110</p> <ul style="list-style-type: none"> - At least one irradiated clone of Napier may be developed
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			<p>Sub-project ID: 110</p> <ul style="list-style-type: none"> - At least one irradiated clone of Napier may be developed  <p>Sub-project ID: 134</p> <ul style="list-style-type: none"> - Component personnel are advised to conduct the pot experiment on maize as per plan <p>Sub-project ID: 135</p> <ul style="list-style-type: none"> - As soon as possible conduct the ineralization study. <p>Sub-project ID: 030</p> <ul style="list-style-type: none"> - Sub-project component personnel are advised to develop fish vaccines as well as demonstrate the efficacy of vaccines at farmers level within the sub-project period <hr/> <p>Sub-project ID: 061</p> <ul style="list-style-type: none"> - Component personnel are advised for integrating all the component technologies as per farming system concept to each selected farmer as well as farmer should not be changed in each year  <p>Sub-project ID: 128</p> <ul style="list-style-type: none"> - Component personnel are advised to identify the diseases of the infected plants as well as advised to frequent visit the mustard fields. <p>Sub-project ID: 096</p> <ul style="list-style-type: none"> - Component personnel are advised to frequent visit the experiment fields.
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7.5 Log frame based performance

Narrative summary	Objectively verifiable indicator (OVI)	Updated progress
<p>Output level</p> <ul style="list-style-type: none"> ▪ Improved performance of the NARS by supporting the development of innovative agricultural technologies and strengthening agricultural research institutions 	<ul style="list-style-type: none"> ▪ 100 CRG and 33 PBRG subprojects implemented ▪ 80 local PhD, 60 foreign PhD, short-term training, study visit etc. implemented ▪ Research and training facilities in outreach stations (RARS/ARS) improved ▪ ICT facilities developed and connectivity established among ARS, RARS and NARI-HQs 	<ul style="list-style-type: none"> ▪ 190 CRGs completed; 51 PBRGs are on-going with satisfactory performance; field monitoring done by 10 ME teams in every year ▪ 80 local and 60 foreign PhD scholars admitted and started course works; 3152 officials received local training, 7505 participated in local workshop/seminar, 51 attended foreign training, 20 participated workshop/seminar abroad, and 39 performed study visit abroad ▪ For up gradation of lab facility, purchase and supply of modern equipment to NARS is yet to be completed possibly by next fiscal year ▪ Assessment has been completed and tender documents are being prepared, to be completed in next year

Chapter 8

Procurement management

8. Procurement progress

Considering the cumulative achievement of procurement, 64% progress has been made against the target of the project of which goods package made 64% progress, works package 40% and services package 77%. (Table 8.1). In this financial year, Out of 19 total packages, 8 (42%) have been procured of which goods 3, works 2 and service 3. (Table 8.2) Details of Procurement Packages in 2019-20 is shown in Table 8.3.

Table 8.1: Cumulative progress of procurement of the PIU-BARC

Activities	Progress to date against project target (%)	
	Package target	Package progress (%)
a. Goods	28	18 (64)
b. Works	15	6 (40)
c. Services	26	20 (77)
Sub-Total	69	44 (64)

Table 8.2: Summary progress of procurement in the FY 2019-20

Activities	Progress	
	Package target	Package progress (%)
a. Goods	6	3 (50%)
b. Works	8	2 (25%)
c. Services	5	3 (60%)
Sub-Total	19	8 (42%)

Table 8.3: Progress of procurement in the FY 2019-20

Sl. No.	Package No.	Package name	Procurement / selection method	Contract price BDT	Name of the supplier/ contractor / consultant
1.	NATP-2/GD/PIU-BARC-12a (Tender ID 398070)	Procurement of Supply & Installation of Equipment: Two (2) Smart LED TV	OTM	11,99,000.00	M/S. F22R
2.	NATP-2/GD/PIU-BARC-14 (Tender ID 420415)	Supply of Office Stationary-3	e-OTM	770109.18	M/S Tradenet International,
3.	NATP-2/GD/PIU-BARC-16 (Tender ID 421411)	Procurement of Printing and Binding Document-2	e-OTM	893722.93	M/S Mohammad Builders,
4.	WD/PIU-BARC/06E (Tender ID 350160)	Repair & Renovation Works of Auditorium, Main Building, BARC	e-OTM	38,64,521.316	M/S RAJ LINE,
5.	NATP-2/PIU-BARC/WD-10c (Tender ID 407784)	Installation of False Ceiling ,Paten stone & Others of Traning Building of BARC	e-OTM	1960000.70	M/S Brothers construction .
6.	SD/PIU-BARC/11a	Technical Assistance-National (Individual) Short term Consultant for Livestock	ICS (Limited)	10,75,000.00	Dr. Kazi Kamar Uddin
7.	SD/PIU-BARC/12b	Technical Assistance-National (Individual) Short term Consultant for Fisheries.	ICS (Limited)	10,75,000.00	Dr. Masud Hossain Khan
8.	SD/PIU-BARC/19	Hiring of Firm for Design, Management and Supervision of Construction Works	QCBS	67,000.00	Modern Engineers Planners & Consultants

Chapter 9

Financial management

9.1 Financial progress

Financial progress is the key of measuring the performance of any of the on-going project. In last week of every month MoA monitors the progress of development projects implementing by different agencies under the Ministry based on financial achievement against the target. The PIU-BARC, NATP-2 is not out of the systems. In each of the months, the Project Director of PIU-BARC is to present the progress of the project to the meeting at MoA under the chairmanship of the Minister (MoA). So, financial progress is the most vital indicator of success of the Project.

9.2 Project financial management

The financial management of the PIU-BARC is governed by the existing Project Accounting Manual issued by Ministry of Finance of GoB. All transactions of the project are accounted by double-entry accounting systems and on a cash basis. Dollar Special Account (DOSA) Funds have been treated as PA which spent as local/foreign exchange. PMU of NATP-2 disbursed fund quarterly to the PIU-BARC as per submitted SoE (Statement of Expenditure). PIU-BARC submits withdrawal applications to the PMU for onward transmission to World Bank (WB) and receive RPA fund accordingly. Transaction of GoB fund is followed existing rules and regulation of the country for Government and semi-government offices.

The summary of DPP's financial allocation, current ADP allocation and corresponding achievement is furnished in the following table 9.1. So far till June 2020 the RADP expenditure of current fiscal year 2019-20 raised to 77.71 % for GoB, 83.56 % for RPA and gross achievement is 83.53 %. The cumulative achievement observed 34.83 % progress in GoB fund, and 40.17 % for RPA and total 40 %.

Table 9.1: Summary of financial progress of PIU-BARC till Jun 2019 (Tk in lakh)

Sources of fund	Progress against RADP 2019-20		Progress to date against project target (%)	
	Target (LT)	Achievement (%)	Target (LT)	Achievement (%)
GoB	38.00	29.53 (77.71)	1245.00	433.66 (34.83)
RPA	6670.00	5573.62 (83.56)	39028.00	15677.46 (40.17)
Sub-total	6708.00	5603.15 (83.53)	40273.00	16111.12 (40)

9.3 Financial progress of PIU-BARC

The revised allocation in the ADP of 2019-2020 is BDT 6708.00 lakh of which GoB BDT 38.00 lakh and RPA BDT 6670.00 lakh). During the fiscal year 2019-20, PIU-BARC spent an amount of BDT 29.53 lakh (77.53%) under GoB funding and BDT 5573.62 (83.56%) lakh under RPA funding. The cumulative progress of the project has observed 34.83% for GoB and 40.17% for RPA allocation against the allocation of Tk 1245 lakh and Tk 39028 lakh for GoB and RPA respectively. The table 9.2 elaborated the allocation and expenditure of the project against major investment items. As operation of CRG sub-projects has been completed the expenditure for the item raised to 73.32%. The total budget of CRG could not be burnt due to time shortage (18 months only). Detailed financial progress of the current year including cumulative progress of the project is shown in the following table 9.2.

Table 9.2 Financial progress in FY 2019-20 (Tk in lakh)

Sl #	Item/Activity/Indicator	DPP target		Target in 2019-20		Achievement in 2019-20		Prog (%) in 2019-20		Cumulative prog till Jun 2020		Cumulative prog (%) till Jun 2020	
		Phy	Fin	Phy	Fin	Phy	Fin	Phy	Fin	Phy	Fin	Phy	Fin
1	Contractual core staff (mm)	1296	647	206	100.00	190	90.60	92.23	90.60	579	265.26	44.68	41
2	National Training/workshop (Batches)	199	695	34	118.50	31	104.74	91.18	88.39	149	496.43	74.87	71.43
3	International Training/workshop (person)	460	2160	24	206.00	24	204.73	100	99.38	111	613.69	24.13	28.41
4	Local PhD (#)	80	1100	80	233.50	80	213.21	100	91.31	80	515.80	100	46.89
5	Foreign PhD (#)	60	4710	60	1065.00	60	1064.75	60	99.98	60	2324.57	100	49.35
6	CRG Sub-project (#)	100	5951	0	0	0	0	0	0	190	4363.52	190	73.32
7	PBRG Sub-project (#)	33	12842	51	4500.00	51	3510.50	100	78.01	51	6185.31	154.55	48.16
8	Consulting Services (mm)	696	3310	108	287.00	108	270.54	100	94.26	263	641.09	37.79	19.37
9	Incremental Operating costs	LS	1582	LS	164.00	LS	110.63	LS	67.45	LS	387.24	LS	24.48
10	Vehicle (#)	7	366	LS	0	LS	0	LS	0	3	123.19	42.86	33.66
11	Capital Expenditure	LS	3472	LS	34.00	LS	33.45	LS	98.38	LS	195.02	LS	5.62
12	Civil works	LS	2125	LS	0	LS	0	LS	0	0	0.00	LS	0
13	CD/VAT	LS	453	LS	0.00	LS	0.00	LS	0	LS	0.00	LS	0
14	Safeguard mitigation	LS	233	LS	0.00	LS	0.00	LS	0	LS	0.00	LS	0
15	Price contingency	LS	628	LS	0.00	LS	0.00	LS	0	LS	0.00	LS	0
Total		2931	40274	563	6708.00	544	5603.15	96.63	83.53	1486	16111.12	58.00	40.00

Chapter 10

World Bank (WB) review mission

10.1 WB review mission

The implementation support mission of WB supervises the field activities of the project at least once in every year since the inception of NATP phase II project. Following matrix showed the time of mission visit in the project-reporting year. The supervision team composed mostly by the sectoral experts working in the WB office at Dhaka including one member from IFAD side.

10.2. Matrix of mission visit

SI No.	Name of mission	Duration	Major decisions
1	Technical Mission	14-18 July 2019	<ul style="list-style-type: none"> Way out of small payment under PBRG
2	3 rd Implementation Support Mission	24 November to 01 December 2019	<ul style="list-style-type: none"> Prepare Technologies Fact Sheet
3	Technical Mission	03-13 February 2020	<ul style="list-style-type: none"> Ten improve technologies will be demonstration in the farmers field

10.3 Review of task and assignment of WB mission

The following table illustrated the actions taken by the PIU-BARC against the observation made by the WB/IFAD Mission visited the project during 14-18 July 2019, 24 November to 01 December 2019 and Technical Mission, 09-13 February, 2019.

Actions	Responsibility	Agreed timeline	Actions taken
Relevant Communication between BFRI research and BARC to be copied to DoF.	PIU-BARC, BFRI, DOF	Effective Immediately Continuous	Complied and Continuing
PhD candidates should discuss with the relevant PIU Directors and project personnel.	PIU-BARC	Effective Immediately Continuous	Complied and Continuing
Scientists engaged with CRG and PBRG sub-projects should have frequent conversations with the extension departments for better synergies and improved technology extension linkages	PIU-BARC with PIUs and PMU	Continuous	Complied and Continuing
Fisheries PhD completion plan/roadmap with timeline should be submitted.	PIU-BARC, DoF and selected 5 candidates	January 31, 2020	Submitted

Report on overseas training, including assessment of trainee performance and post-training plan to facilitate dissemination and uptake of new skills acquired (training of trainer, proposal to uptake innovation, etc.)	PIU-BARC	February 29, 2020	To be submitted
Submit revised PhD program completion time both in county and overseas.	PIU-BARC	January 31, 2020	Submitted
Factsheet of technologies (68) to be handed to extension department	PIU-BARC	April 15, 2020	69 factsheets prepared and uploaded in the website of PIU-BARC
Improved technologies (10) will be demonstrated in the farmers' fields of the project area.	PIU-BARC with support from PIU-DAE, PIU-DoF and PIU-DLS	June 30, 2020	PIU-BARC handed over 11 (6 crop, 3 livestock and 2 fisheries) technologies to DAE, DLS and DoF for field demonstration and will be demonstrated in current Financial Year
Policy Dialogue/workshop on Research Extension Linkage and Partnership Development.	PIU-BARC and PMU	May 30, 2020	To be done by PIU-BARC with the assistance of PMU
Review annex on food safety and identify interest and options to	PMU with support of PIU-	January 31, 2020	Reviewed food safety issues and identified 33
further strengthen attention and visibility to food safety within NATP2.	BARC, DAE, DLS, DoF		CRG and 28 PBRG sub-projects to contribute food and nutritional security.
BARC to publicly disclose the information on CHT related researches on its website and other media.	PIU-BARC	February 20, 2020	Uploaded in the the website of PIU-BARC on 20 February 2020
First Environmental Safeguard Compliance Report.	PMU and PIUs	December 31, 2020	Submitted on 30 December 2020 to PMU/WB
Meetings between WB team and environmental focal points of each component to discuss the type and extent of climate-smart agriculture activities.	World Bank with PMU and PIUs	May 2020 (ISM4)	(No meeting has been organized by WB team but PIU-BARC identified 17 CRG and 6 PBRG sub-projects related to climate-smart agriculture (CSA)

Training on GHG Accounting with the EX-ACT tool for PMU and PIUs specialists.	World Bank	May 2020 (ISM4)	No formal training has been organized by WB
Quantification of climate co-benefits and GHG Accounting.	World Bank with PMU and PIUs	April 30, 2020	Identified 27 CRG sub-projects and 6 PBRG sub-projects and 27 PhD research topics are related to climate adaptation, resilience or mitigation in agriculture.
Incorporate climate reporting in relevant project reports.	World Bank with PMU and PIUs	May 31, 2020	Identified 15 PBRG sub-projects need climate reporting
Resolve the outstanding external audit observations for FY16-17.	PMU with PIU-BARC and PIU-DoF.	June 30, 2020	PIU-BARC and DoF submitted further reply to FAPAD. Resolved 11 observations of FY2017-18 by FAPAD.
Draft report to review and enhance integration and inclusiveness in extension planning, for instance along: i) UECC/DECC meeting; ii) cross-sectoral discussions and aggregation of micro-extension plans at village/Union/CCMC levels, promoting cross sectoral innovations (e.g. fish-rice) and services; iii) attention to gender, social inclusion and climate in extension planning (potentially at village level as well).	PMU with support of PIU-BARC, DAE, DLS, DoF	March 31, 2020	Planned to be started in next fiscal year.

Chapter 11

Challenges and lesson learned

11.1 Challenges faced

The PIU-BARC faced difficulty in hiring International Consulting Firm for implementing overseas PhD, training/workshop and other programs. It delayed the processing of foreign PhD and raised complexity in disbursement of foreign exchange to the PhD scholars. This issue may demand additional time for completion of Ph. D programs beyond present project period. The up scaling programs of scalable technologies into the farming community involving extension agencies (public and private) would require additional resources and time.

The specific challenges are:

- Completion of PBRG sub projects in due time
- Execution of Overseas training, workshops, seminar and Visit etc. during COVID-19
- Completion of PhD Program within Project Period
- Completion of procurement of lab equipment in time
- Completion of ICT facilities for NARS institutes
- Execution of Infrastructure Development in NARIs
- The PIU-BARC faced difficulty in hiring International Consulting Firm for implementing overseas PhD, training/workshop and other programs. It delayed the processing of foreign PhD and raised complexity in disbursement of foreign exchange to the PhD scholars.
- Organize the international training and study visit program without international consulting firm is very difficult.
- Provision of issuing cheque for tiny payment (national training, workshop, seminar etc.) creates inconveniences for the participants and other clients.
- Delayed to recruit the international consulting firm
- Covid-19 disease problem
- Selection of foreign organizing firm for organize international training and study visit
- Organize international training and study visit
- Organize air ticket for international training and study visit

11.2 Lessons learned

1. PBRG sub-projects are addressing specific research agenda that generate technology within specific timeframe involving inter and multi-disciplinary team members
2. PBRG sub-projects enable researcher to work on key problems, develop institutional linkages and capacities across organizations
3. PBRG programs have widen the scopes in integrating multiple organizations for jointly combating national agricultural problems and strengthening research and research management capability
4. Virtual platform can be used as an alternate option to communicate with implementing organizations and other stakeholders to perform project activities in the COVID pandemic situation.

Project team

The PIU-BARC of NATP phase II project is headed by the Director deputed from BARC. Except Director all other officers, consultants and support staff are recruited by the project under contractual services for the project period or as per design (DPP) of the project. A list of consolidated manpower presently working with the PIU-BARC has furnished as below.

List of management staff in PIU-BARC, NATP-2 as on 30 June, 2020

SI	Name and position	Address
1.	Dr. Md. Harunur Rashid Director	Address: Flat # B-2, House # 44, Road # 18, Sector # 7, Uttara Model Town, Dhaka-1230. Mobile No: 01716-950421, E-mail: directornatpbarc@gmail.com
2.	Dr. Md. Abdul Jalil Bhuyan Research Management Specialist	Address: House # 61, Road # 16, Sector# 11, Uttara, Dhaka-1230, Mobile No: 01552-491457 E-mail: maj.bhuyan54@yahoo.com
3.	Dr. Nowsher Ali Sarder Monitoring and Evaluation Specialist	Address: Flat # A1, Building: Janani, 35 Indira Road, Tejgaon, Dhaka. Email: nsarder@gmail.com
4.	Md. Mokhlesur Rahman Training & Communication Specialist	Address: 58, 1/b, West Rajabazar, Farmgate, Dhaka Mobile No: 01710-807313, E-mail: mokhles12@yahoo.com
5.	Mohammad Assaduzzaman Manager (Financial Management)	Address: 84/23, Vasantac, Dhaka Cantonment, Dhaka, Mobile No: 01912-241-929 E-mail: natp.barc.fin@gmail.com
6.	Md. Shahidul Islam Procurement Specialist	Address: Flat # A-6, House # 578, Noyatola Central Point, R/S, Modhubag, Maghbazar, Dhaka. Mobile: 01717-138784, Email: eqss.bmda@gmail.com
7.	Dr. Md. Serajul Islam Environmental and Social Safeguard Specialist	Address: Flat # A-1, House # 44, Road # 18, Sector # 7, Uttara Model Town, Dhaka-1230. Mobile No. 01552-387178, Email: msislam52@yahoo.com
8.	Dr. Mohammad Abdullah Al-Faroque Assistant Manager (Administration)	Address: 1/21/5, East Bashabo, Kadamtola Road, Shabujbag, Dhaka-1214, Mobile No: 01711-061147 E-mail: faroquekbd@gmail.com
9.	Md. Ashequr Rahman Assistant Manager (Accounts)	Address: C/O- Md. Abdul Malek, BUTEX R/A-1, Dalia Building, C/13, South Begunbari, Tejgaon, Dhaka Mobile No: 01912-575317 E-mail: asik0852@yahoo.com
10.	Munshi Mamunur Rahman Documentation Associate	Address: House # 42, Road # 4, Monsurabad, Adabor, Dhaka, Mobile No: 01978-387610 E-mail: mamun71t@yahoo.com
11.	Md. Abdur Rahaman Monitoring Associate	Address: 24, Monipuripara, Sangsod Avenue, Tejgaon, Dhaka-1215, Mobile No: 01711-233030 E-mail: agriltechnology@gmail.com

SI	Name and position	Address
12.	Mr. Dipok Kumar Monitoring Associate	Address: 101, Niribili (7 th Floor), West Raja Bazar, Dhaka. Mobile No: 01716-210375 E-mail: dipokbarc@gmail.com
13.	Mr. Md. Hasan Mahmud Capacity Development Associate	Address: 146, Bochila (South) 2 nd Floor, Mohammadpur, Dhaka-1207. Mobile No: 01819-187798, E-mail: cdanatp2@gmail.com
14.	Nadia Rahnuma Accountant	Address: 40/2, Zigatola, Dhaka Mobile No: 01670-017531 E-mail: rahnuma13@gmail.com
15.	Monir Ahamed Khondaker Accountant	Address: H # 3/C, R # 1, Block # kha, Pisciculture Housing Society, Mohammadpur, Dhaka Mobile No: 01916-045587 E-mail: ripon782002@yahoo.com
16.	Mr. Md. Anowarul Islam Computer Operator	Address: 56 (Middle building), West Rajabazar, Dhaka, Mobile No: 01630-277172 E-mail: maislam.nijhum@gmail.com
17.	Ms. Asma Akhter Computer Operator	Address: 279, Zafrabad, Shonkor, Dhaka Mobile No: 01911-283203, E-mail: asla9@yahoo.com
18.	Md. Shahinur Islam Photocopy, Multimedia, PA System Operator	Address: College Road, Bank Colony, Block #H, 60/1, Savar, Dhaka, Mobile No: 01818-280849

NATP-2 Annual Report 2019-20 PIU-BARC

